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Agricultural Airplane Mission Time Structure Characteristics

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SUMMARY

A study of the time structure characteristics of agricultural airplane missions has been made by using records from NASA VGH flight recorders. Results from the study indicate flight durations varied from less than 3 minutes to more than 103 minutes. There was a significant reduction in turning time between spreading runs as pilot experience in the airplane type increased. Spreading runs accounted for only 25 to 29 percent of the flight time of an agricultural airplane. Lowering the longitudinal stick force appeared to reduce both the turning time between spreading runs and pilot fatigue at the end of a working day.

INTRODUCTION

The primary elements of the time structure of an agricultural flight are total flight time, ferry time, spreading time, and turning time. A knowledge of these values is necessary not only to the airplane designer to enable valid estimates to be made of the task requirements of the airplane but also to the operator to provide reasonable estimates of the utility that may be expected from the airplane. Since NASA VGH flight recorders have been installed on agricultural airplanes for a number of years, such data were readily available; accordingly, records from 12 airplanes representing light-piston-powered, heavy-piston-powered, and heavy-turbine-powered classes have been analyzed and the results are reported herein. Other studies relating to time analysis of agricultural flights are given in reference 1.

INSTRUMENTATION

Data used in the analysis were obtained from NASA VGH flight recorders installed on agricultural airplanes used in actual operations. These recorders provide a time-history record of indicated airspeed (V), normal acceleration (G) at or near the center of gravity of the airplane, and pressure altitude (H). Photographic paper 2 3/4 inches wide and 175 feet long is used for the recording medium and is transported in the recording drum at a speed of 1/2 inch per minute (about 70 hours total recording time). The recorder base and drum have a combined weight of 17 pounds and the remote accelerometer has a weight of 2 1/4 pounds. A complete description of the recorder is given in reference 2.

METHOD OF ANALYSIS

Airplane Selection

Only VGH records from airplanes specifically designed for agricultural operations were used in the study. Eight types of airplanes, whose operations, characteristics, and sample sizes are listed in tables I and II, were selected to provide representative data. The eight airplane types are identified by the numbers 1 through 8, with types 4 through 8 divided into a and b sets for comparative purposes. Airplane types 1, 2, and 3 are in the light-piston-powered class (A); types 4, 5, and 6 are in the heavy-piston powered class (B); and types 7 and 8 are in the heavy-turbine-powered class (C). Twelve individual airplanes were used in the data sample:

three in the light-piston-powered class flown by operators in Texas, Louisiana, and Montana; six in the heavy-piston-powered class flown by two operators in Arizona, two in Texas, one in California, and one in Oregon; and three in the heavy-turbine-powered class flown by one operator in Alabama and two operators in Texas.

Data Identification

An example of a typical agricultural flight as it appears on the VGH record is shown in figure 1. Pertinent traces and trace responses are identified in the figure. Each flight on the VGH record was identified as a spreading or cross-country flight. Only spreading flights were evaluated. Each flight was divided into three basic segments - ferry, spreading runs, and turns between spreading runs - and the time flown in these segments was determined in seconds and recorded. Flight time was considered to be the elapsed time from lift-off to landing touchdown.

Identification of the ferry, spreading runs, and turns between the spreading runs was made on the VGH record by correlating responses of the altitude, acceleration, and airspeed traces. Ferry time is defined as that portion of flight from lift-off to the start of the first spreading run and from pull-up at the end of the last spreading run to landing touchdown. For flights where two or more fields are worked, the time from pull-up on the last spreading run at one field to the start of the first spreading run on the next field was also considered ferry time.

Turning time between spreading runs is identified as the time consumed in maneuvering the airplane from its position at the end of one spreading run to its position at the start of the next spreading run. The timing of turns between spreading runs on the VGH records was aided by the easily recognized spreading runs discussed in the next paragraph.

Spreading runs are defined as the segment of an agricultural flight in which seeds or chemicals are released from the airplane to sow or protect crops. They are identified on the VGH record by regular, flat portions of the altitude trace; by the relatively steady 1.0g position of the acceleration trace during the spreading run; by the increase in airspeed prior to the start of the spreading run; and by the sharp decrease in airspeed at the end of the spreading run. Spreading time was not measured directly from the VGH record as were ferry time and turning time; instead it was determined by adding the ferry and turning times and subtracting this summation from the flight duration.

In addition to determining the ferry, spreading, and turning times, the number of spreading runs and the number of turns between spreading runs were also recorded for each flight.

Data Analysis

Although the data sample for the analysis varies considerably between airplane types and is relatively small (represents less than one season, 331.6 hours with 18 780 spreading runs) compared with samples used in flight load analyses, it is considered of value for documenting pertinent agricultural mission time characteristics.

A detailed record of the mission time characteristics exhibited by different airplane types and weight classes is given in tables III and IV. Data samples were arranged into groups of flights having multiples of five spreading runs. These groups are noted in the extreme left column of both tables. The following information is given for each group: the number of flights; the number of spreading runs; the number of turns between spreading runs; the maximum, minimum, and average flight time, ferry time, spreading time, time per spreading run, turning time, and time per turn; and the percent of flight time used for ferry, spreading runs, and turns between spreading runs. The data are summarized for each particular sample at the bottom of each table. These tables form a logical array of information pertinent to the flight operations of each airplane type and weight class, and they provide the major basis for analysis of the different data sets.

The maximum and minimum values in tables III and IV for the spreading time per run and for the turning time per turn are for individual flights in each group. They were obtained by dividing the total run (or turn) time for each flight by the total number of runs (or turns) in the flight. The maximum and minimum values are presented primarily to indicate the weighted limits of the average values.

In order to show the effects of pilot experience, of control force changes, or of different operators on agricultural airplane mission time characteristics, the data from airplane types 4 through 8 were separated into a and b sets. These sets are noted in table I for each airplane type.

Figures 2 through 10 are histograms of mission characteristics exhibited by the different airplane types and classes given in tables III and IV. Data for the figures were taken from tables III and IV and represent the total data sample for each type or class of airplane. The histograms were used to facilitate comparison of data from one type or class of airplane with another.

RESULTS AND DISCUSSION

Results from the analysis are discussed in the following order: flight time, ferry time, spreading time, turning time, and flight profiles. Of primary interest are the variation in flight time for different tasks by the same or different airplane types; the variation in ferry time, spreading time, and turning time; and the percent of an agricultural flight time used for ferry, spreading runs, and turns between spreading runs.

Flight Time

The variation of flight time with the number of spreading runs made per flight for different types and classes of airplanes is given in tables III and IV. In general, flight time varies directly with the number of spreading runs; however, because of longer ferry distances, longer spreading runs, or different patterns flown to set up spreading runs, some flights with less spreading runs are longer in duration than other flights with more spreading runs. A comparison of the flight duration for different airplane types and classes is given in figure 2. The data are presented in bar-graph form and show the maximum, minimum, and average flight times for the individual airplane types and the three classes.

The longest flight time, 103.3 minutes, was recorded by airplane type 1, the smallest airplane in the data set. The shortest flight time, 2.7 minutes, was recorded by airplane type 2, also one of the smallest airplanes in the data sample. A comparison of maximum and minimum flight times for the eight airplane types shows relatively large variations in the maximum flight times but small variations in minimum flight times. This suggests that the minimum spreading time, regardless of type, is about 3 minutes and one or more of these short flights can be expected during a season's operation. The relatively large differences between the minimum and the maximum flight times indicate the random nature of the operational requirements for agricultural airplanes. Although some of the airplanes recorded maximum flights of less than 30 minutes, others recorded flights in excess of 100 minutes. Figure 2(a) indicates that only types 1 and 8 had average flight times of more than 20 minutes, and three of the airplanes had flight times of less than 10 minutes. If flight time for all airplanes in the data sample is summed and divided by the total number of flights, the average flight time is 15 minutes.

The variation in flight time for the light-piston-powered, heavy-piston-powered, and heavy-turbine-powered classes of airplanes is shown in figure 2(b). Airplanes in the light-piston-powered and heavy-turbine-powered classes recorded the longest flight times - slightly more than 100 minutes - whereas the heavy-piston-powered class of airplanes had maximum flight times of about half that. The minimum flight time, 2.7 minutes, was practically the same for all three categories of airplanes; this indicates that all the categories have requirements for short flights. Average flight times varied between 13 and 18 minutes with the longest flight recorded by the light-piston-powered airplanes and the shortest by the heavy-piston-powered airplanes. These differences in the average flight times suggest that no correlation exists between airplane class and flight time.

Ferry Time

The time required to fly to, from, and between work areas (ferry time) is of interest to both the airplane designer and the operator. These data are of interest to the designer because of the relatively light maneuver accelerations experienced in this period of the flight compared with the severe maneuver accelerations required during spreading operations and to the operator because of flight planning and monetary considerations.

As indicated by table III, there is no correlation between ferry time and the number of spreading runs made during a flight or between ferry time and flight time for a specific airplane type. Figure 3 shows the maximum, minimum, and average ferry times for the individual airplane types and for the three classes of airplanes. The longest maximum, minimum, and average ferry times were recorded by airplane type 8, one of the heavy-turbine-powered airplanes. This result was expected, since an airplane such as type 8 would be expected to be used for jobs at more distant locations from the base of operations; however, examination of the data from airplane type 7, another heavy-turbine-powered airplane, shows that it recorded the shortest maximum and average ferry times of all the airplanes considered. These differences illustrate the wide variety of applications in which the heavy-turbine-powered agricultural airplanes are utilized. A comparison of ferry times for the three weight classes of airplanes shows that the longest ferry time, 80 minutes, was recorded by airplanes in the heavy-turbine-powered class and the shortest, about 0.5 minute, was recorded by airplanes in the light-piston-powered class. The average ferry time for

all three classes of airplanes was about 5 minutes; this indicates that most of the fields worked, regardless of the airplane weight class, were within 2 1/2 minutes of the base of operations.

Spreading Time

The portion of an agricultural flight utilized for spreading runs represents the single most important phase of the flight - that period in which the airplane is performing the function for which it was designed. The amount of time consumed spreading chemicals or seeds on an agricultural flight and the average time required per spreading run for each airplane type and class are given in tables III and IV. In general, spreading time varies directly with the number of spreading runs; however, because of variations in field sizes and application speeds, some flights with fewer spreading runs require longer spreading times.

A bar graph of the time per flight for spreading runs is shown in figure 4. Data were taken from tables III and IV and represent the total data sample for each airplane type and class. The data show that, with the exception of type 1, the majority of the individual airplane types have maximum spreading times of less than 18 minutes and average spreading times of less than 5 minutes. All airplanes except type 1 recorded minimum spreading times of less than 1 minute. A comparison of spreading times for the three classes shows the heavy-piston- and heavy-turbine-powered classes to be quite similar with maximum spreading times per flight of about 15 minutes and average spreading times of 4 minutes. Airplanes in the light-piston-powered class (type 1) recorded maximum spreading times of 38 minutes and average spreading times of around 5 minutes. Minimum spreading times for airplanes in the three classes were less than 1 minute. When data from all airplanes in the sample were combined, the overall average spreading time per flight was about 4 minutes. The increased spreading time for airplanes in the light-piston-powered class is believed to result from lower spreading speeds and from more spreading runs per flight. (See tables II and IV(a).)

If the average time per spreading run for the different airplane types and classes is known, some idea is gained on the distribution of field sizes worked in the data sample. This information is provided by figure 5 and shows that the longest spreading runs were slightly over 50 seconds and the shortest runs were around 4 seconds. VGH records from airplanes of the same type as listed, but whose data were not evaluated in depth, have shown spreading runs as long as 2 minutes 45 seconds and as short as 3 seconds. For the data presented herein, average run times vary between 13 and 21 seconds for the individual airplane and between 16 and 19 seconds for the three classes of airplanes.

Turning Time

The data in table III show that, as the number of spreading runs in a flight increase, the portion of the total flight time required for turns between runs also increases. There are exceptions to this, however, since different field shapes and obstructions around the field mandate changes in turn patterns flown between the runs. The time to turn from one spreading run to the next appears to be random and is not affected by the number of runs made per flight. The time per flight for turns between spreading runs for different airplane types and classes is shown in figure 6. These data indicate that relatively large variations exist between maximum values for the eight types of airplanes and between maximum and minimum values for

specific airplane types. Differences were also relatively large between the average time per flight for turns between spreading runs for the individual airplane types. When the airplanes were grouped into classes, only maximum turning time for the light-piston-powered class (strongly influenced by aircraft type 1) was significantly different, about twice the turning time recorded by the heavy-piston- and heavy-turbine-powered classes. (See fig. 6(b).)

The maximum, minimum, and average times per turn between spreading runs for the different airplane types and classes are given in figure 7. Turning times varied from a maximum of 52 seconds for airplane type 8 to a minimum of about 15 seconds for airplane type 7. Average time per turn for the individual airplane types was between 24 and 36 seconds. Smaller differences were evident between turning times for the three airplane classes. Differences between maximum times were about 6 seconds, and between minimum times, 1 1/2 seconds. Average time per turn between spreading runs was 28 seconds for airplanes in the light- and heavy-piston-powered classes and 24 seconds for those in the heavy-turbine-powered class.

The effect of pilot experience in a given airplane type on the time per turn between spreading runs is illustrated by comparing the time per turn listed in table III(d) with similar information in table III(e). The data in table III(d) represent the initial flights made after purchase of airplane type 4. Data in table III(e) were taken from the same airplane flown by the same pilot 3 months later. Since care was taken to compare flights with reasonable likenesses (flight time and number of turns per flight), the decrease in turning times from table III(d) to table III(e) may be attributed to increased pilot familiarity with the handling characteristics of the airplane. A comparison of the overall average time per turn for the initial data in table III(d), 39.6 seconds per turn, with the later data in table III(e), 32.4 seconds per turn, indicates a decrease in time per turn of 7.2 seconds, which is a significant reduction. Maximum and minimum turn times showed similar reductions.

The effect of an elevator antiservo tab on the time per turn is indicated by comparing the data for time per turn in table III(m) with those in table III(n). Data in table III(m) were taken with the elevator antiservo tab disconnected (lower stick force), and data in table III(n) were obtained with the same airplane and pilot but with the antiservo tab connected (higher stick force). Flights which had similar characteristics were chosen for the comparison (similar flight times and a comparable number of spreading runs). Examination of the data shows that, with the antiservo tab connected, the time per turn was more than with the tab disconnected. There were flights in which turning times were less with the antiservo tab connected; statistically, however, this should be expected since variations in field sizes, perimeter obstructions on the fields being worked, or differences in the pattern being flown to work the fields influence the rate of turn. Overall, however, the average time per turn between spreading runs was 2.6 seconds less when the antiservo tab was disconnected.

One explanation for the differences in turning time may be pilot fatigue. Because of the many pull-ups, push-overs, and turning maneuvers agricultural pilots make (1 to 2 orders of magnitude more than in any other type of operation), the pilot's arm is weakened after several hours of operation. (See ref. 3.) When work-days of 8 to 10 hours are encountered, the pilot is physically unable in the latter part of the day to maintain control-stick back pressures equivalent to those used during the first part of the day; consequently, more time is required to make the turn. Telephone conversations with the pilot confirmed that there was a significant increase in physical fatigue when the elevator antiservo tab was connected.

Flight Profiles

Agricultural flights are composed of three primary segments: ferry time (time of flight to, between, and from work areas); spreading time; and turning time between spreading runs. The relationship of these time segments, one to the other, relates to the effectiveness of the flight. Ideally a working flight should have minimum ferry and turning times and maximum spreading time.

The variation in the percent of flight time used for ferry, spreading, and turns by airplane type and class is given in tables III and IV. Figures 8, 9, and 10 present the data sample for each type and class of airplane and give the maximum, minimum, and average percent of the flight time used for ferry, spreading, and turns between spreading runs. These figures allow a comparison of the percent flight time consumed in each flight by the different types and classes of airplanes. By considering first the individual aircraft types and comparing the three phases of the flight, the figures show that all airplanes, except type 1, spend the largest percent of their flight time ferrying the airplane and making turns between spreading runs. The smallest percent of an agricultural flight is used for spreading runs. The exception to this was airplane type 1, which used 37 percent of its flight time for spreading runs, 17 percent for ferrying, and 46 percent for turns between spreading runs.

The relatively large variations in flight profiles - even for a specific airplane type - indicate the breadth of requirements imposed on agricultural airplane operations. Examination of figures 8(a), 9(a), and 10(a) shows ferry differences of from 6 to 78 percent of the flight time, spreading differences of from 6 to 46 percent of the flight time, and turning differences of from 15 to 70 percent of the flight time.

When data from the individual airplane types are grouped into light-piston-, heavy-piston-, and heavy-turbine-powered classes, figures 8(b), 9(b), and 10(b) show that the largest variations in the percent of agricultural flight time are used ferrying the airplanes to, from, and between work areas and in making turns between spreading runs. The smallest variation between the three classes of airplanes was experienced in spreading times. Figures 8(b), 9(b), and 10(b) also show that the average percent of the flight time for ferrying, spreading, and turning was, respectively, 31, 29, and 40 percent for light-piston-powered airplanes; 31, 25, and 44 percent for heavy-piston-powered airplanes; and 38, 25, and 36 percent for heavy-turbine-powered airplanes. If comparison is made of the percent ferry, spreading, and turning times (33, 27, and 40, respectively) for the complete data sample, it is seen that the largest portion of an agricultural flight is consumed making turns between spreading runs.

Overall the data indicate larger differences within given classes than between different classes of agricultural airplanes; this again indicates the wide range of task requirements faced by agricultural airplanes, regardless of airplane class. The most efficient operation - if efficiency is defined as spending the largest percent of a flight on spreading runs - was recorded by airplanes in the light-piston-powered class; however, even these airplanes spent only 29 percent of their flight on spreading runs.

CONCLUSIONS

An analysis of the mission time structure characteristics of eight types of agricultural airplanes based on a data sample of 331.6 hours and 18 780 spreading runs suggests the following conclusions:

1. Agricultural airplanes spend the smallest portion of their flight, from 25 to 29 percent, doing that for which they were designed - spreading seed or chemicals. On a time basis, spreading time per flight varied from less than 1 to about 38 minutes, with an overall average of 4 minutes.

2. A significant reduction in turning time between spreading runs occurs as pilot experience in a new airplane type increases.

3. A reduction in turning time between spreading runs was achieved on one airplane type by disconnecting the elevator antiservo tab which lowered the stick force necessary for a given turn rate. Pilot comments indicated that because of the lower stick force there was a significant reduction in pilot fatigue at the end of a working day.

4. Relatively large differences are evident between the maximum flight times for the different airplane types; however, for all types the minimum flight time was about 3 minutes. When the data were combined, the overall average flight time was 15 minutes.

5. Although ferry times varied from 0.5 to 80 minutes, the average was about 5 minutes; this indicates that most of the fields worked were within 2 1/2 minutes of the loading area.

6. The percent of an agricultural flight consumed in turns between spreading runs ranged from 15 to 70 percent and averaged 40 percent, the largest of the three basic flight phases.

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TABLE I.- AIRPLANE OPERATIONS

Airplane type	Airplane class	Number of airplanes	Number of operators	Number of pilots	State of home base
1	Light piston	1	1	1	Texas
2	Light piston	1	1	1	Louisiana
3	Light piston	1	1	1	Montana
4	Heavy piston	1	1	1 (a No experience in type; b Experienced in type)	Arizona
5	Heavy piston	3	3	3	a 1 in California b 2 in Texas
6	Heavy piston	2	2	2	a 1 in Arizona b 1 in Oregon
7	Heavy turbine	1 (a Antiservo tab disconnected; b Antiservo tab connected)	1	1	Texas
8	Heavy turbine	2	2	2	a 1 in Alabama b 1 in Texas

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TABLE II.- AIRPLANE CHARACTERISTICS AND DATA SAMPLE SIZE

Characteristics	Airplane types and classes												
	Light piston			Heavy piston						Heavy turbine			
	1	2	3	4a	4b	5a	5b	6a	6b	7a	7b	8a	8b
Maximum gross weight, lb	2900	*4000	*4200	*6900	*6900	*6000	*6075	*6000	*6000	*6075	*6075	*8200	*8200
Wing area, ft^2	183.0	202.0	205.0	270.6	270.6	326.0	328.0	326.6	326.6	328.0	328.0	326.6	326.6
Wing span, ft	36.2	40.7	41.7	45.1	45.1	35.7	35.9	44.3	44.4	35.7	35.7	44.4	44.4
Length, ft	24.7	26.3	26.3	27.0	27.0	24.5	24.3	27.5	29.4	27.0	27.0	33.0	33.0
Height, ft	7.2	7.0	7.7	8.5	8.5	10.8	10.8	8.6	9.2	11.0	11.0	9.2	9.2
Hopper capacity, gal	150	200	280	320	320	300	300	300	400	300	300	400	400
Type propulsion	Piston	Piston	Piston	Piston	Piston	Piston	Piston	Piston	Piston	Turbine	Turbine	Turbine	Turbine
Horse power	235	300	300	600	600	600	600	650	600	750	750	750	750
Flight time, hr	61.0	38.6	29.3	15.6	15.3	2.6	17.8	35.4	26.2	14.3	14.0	26.1	33.2
Spreading run:													
Time, hr	22.5	7.7	6.8	2.9	3.5	0.5	5.1	10.4	6.2	4.6	4.0	7.4	6.8
Speed, knots	66 to 80	85 to 109	80 to 107	92 to 110	93 to 115	72 to 90	85 to 105	85 to 105	91 to 112	85 to 105	90 to 107	91 to 135	94 to 131
Ferry:													
Time, hr	10.4	19.5	9.9	3.6	4.3	1.3	6.8	8.3	11.4	4.4	4.1	8.2	17.7
Speed, knots	63 to 79	85 to 105	80 to 100	90 to 105	90 to 105	70 to 90	90 to 105	75 to 100	95 to 110	75 to 105	85 to 104	115 to 135	100 to 125
Turn time, hr	20.1	11.3	12.6	9.0	7.5	0.7	6.7	16.7	8.5	9.4	5.9	10.6	10.8
Number of flights	84	252	92	50	49	23	103	151	131	103	103	100	52
Number of spreading runs	3891	1625	1446	871	870	112	961	2395	1463	948	938	1799	1473

*Restricted category.

TABLE III.- OPERATIONAL DATA FROM EIGHT TYPES OF AGRICULTURAL AIRPLANES

(a) Airplane type 1, light piston

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5																								
5 to 10	9	52	43	585	366	444.2	209	137	168.0	161	115	135.1	32.2	15.5	23.4	254	103	141.1	32.6	25.8	29.5	37.8	30.4	31.8
10 to 15	6	73	67	1183	710	934.3	768	251	421.0	194	130	166.0	16.9	11.0	13.6	447	290	347.3	35.7	25.4	31.1	45.1	17.8	37.2
15 to 20	2	34	31	1253	982	1117.5	593	489	541.0	200	145	172.5	11.1	9.1	10.1	460	348	404.0	27.1	24.8	26.1	48.4	15.4	36.2
20 to 25	4	88	82	3113	1305	1837.0	2045	242	832.8	703	118	391.5	33.5	4.9	17.8	714	471	612.8	32.1	26.2	29.9	45.3	21.3	33.4
25 to 30	5	134	129	3367	1273	1955.8	2013	48	490.2	1009	443	764.2	34.8	17.0	28.5	825	538	701.4	31.3	21.5	27.2	25.1	39.1	35.9
30 to 35	6	190	184	2530	1414	1998.7	799	83	511.2	884	557	701.8	26.7	18.6	22.2	883	680	785.7	27.0	21.9	25.6	25.6	35.1	39.3
35 to 40	4	147	142	2364	1546	1860.5	545	117	258.8	1078	336	619.0	29.9	8.6	16.8	1055	914	982.8	30.1	25.1	27.7	13.9	33.3	52.8
40 to 45	8	345	336	3761	1770	2494.3	1216	184	420.4	1353	507	948.4	31.6	11.8	22.0	1272	960	1125.5	29.6	22.9	26.8	16.9	38.0	45.1
45 to 50	6	283	277	4051	1613	2923.0	1274	104	326.3	1617	455	1331.3	34.4	10.1	28.2	1659	1050	1365.3	36.1	23.9	27.4	11.2	45.5	43.3
50 to 55	4	210	205	3002	2873	2925.3	536	177	269.0	1461	1130	1336.5	27.6	21.3	25.5	1361	1257	1319.8	26.8	24.5	25.8	9.2	45.7	45.1
55 to 60	1	59	58	3437	3437	3437.0	489	489	489.0	1311	1311	1311.0	22.2	22.2	22.2	1637	1637	1637.0	28.2	28.2	28.2	14.2	38.1	47.6
60 to 65	6	376	366	3817	2231	3164.0	1176	96	330.5	1705	757	1291.2	28.0	12.0	20.6	1758	1378	1542.3	28.4	22.2	25.3	10.4	40.8	48.7
65 to 70	4	271	266	3806	3346	3533.3	582	206	364.8	1637	938	1377.5	23.7	13.6	20.3	1963	1673	1791.0	28.9	25.3	26.9	10.3	39.0	50.7
70 to 75	2	140	138	3782	3160	3471.0	285	163	224.0	1645	1386	1515.5	23.5	19.8	21.7	1852	1611	1731.5	26.8	23.3	25.1	6.5	43.7	49.9
75 to 80	4	304	297	4517	3025	3934.5	600	293	444.5	2178	1051	1648.5	29.0	13.6	21.7	2126	1681	1841.5	28.3	22.7	24.8	11.3	41.9	46.8
80 to 85	3	248	243	5120	3698	4174.3	779	369	528.0	2285	1005	1484.3	27.5	12.4	18.0	2399	2010	2162.0	29.3	24.2	26.7	12.6	35.6	51.8
85 to 90	2	172	169	6200	4727	5463.5	2400	578	1489.0	1937	1594	1765.5	22.3	18.8	20.5	2212	2206	2209.0	26.3	26.0	26.1	27.3	32.3	40.4
90 to 95	4	370	364	5203	4360	4751.3	1125	474	850.8	1528	1283	1425.3	16.4	14.9	15.4	2596	2153	2475.3	28.7	23.7	27.2	17.9	30.0	52.1
95 to 100	2	193	188	5095	4228	4661.5	610	285	447.5	2120	1590	1855.0	21.9	16.6	19.2	2365	2353	2359.0	25.2	25.0	25.1	9.6	39.8	50.6
100 to 105	2	202	200	5816	5218	5517.0	1374	380	877.0	2183	1720	1951.5	21.6	17.0	19.3	2722	2655	2688.5	27.2	26.6	26.9	15.9	35.4	48.7
Total sample																								
46.3	84	3891	3785	6200	366	2614.8	2400	48	454.4	2285	115	964.8	34.8	4.9	20.8	2722	103	1195.5	35.7	21.5	26.5	17.4	36.9	45.7

[a]Based on averages per flight.

BEST DOCUMENT AVAILABLE

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TABLE III.- Continued

(b) Airplane type 2, light piston

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5	104	372	268	708	162	364.8	586	32	219.0	202	20	73.8	50.5	6.7	20.6	113	22	72.1	46.0	20.0	28.0	60.0	20.2	19.8
5 to 10	109	741	631	1198	282	605.7	914	90	307.2	205	25	121.8	29.3	5.0	17.9	310	67	176.6	44.6	16.8	30.5	50.7	20.1	29.2
10 to 15	32	375	343	1805	491	816.8	918	106	326.1	432	112	167.8	30.9	8.1	14.3	455	210	322.9	41.6	16.9	30.1	39.9	20.6	39.5
15 to 20	5	89	84	1310	830	1264.2	877	180	580.6	252	135	201.2	14.0	8.4	11.3	548	392	482.4	32.2	26.1	28.7	45.9	15.9	38.2
20 to 25	1	22	21	1281	1281	1281.0	500	500	500.0	190	190	190.0	8.6	8.6	8.6	591	591	591.0	28.1	28.1	28.1	39.0	14.8	46.1
25 to 30	1	26	25	1125	1125	1125.0	200	200	200.0	195	195	195.0	7.5	7.5	7.5	730	730	730.0	29.2	29.2	29.2	17.8	17.3	64.9
30 to 35																								
35 to 40																								
40 to 45																								
45 to 50																								
50 to 55																								
55 to 60																								
60 to 65																								
65 to 70																								
70 to 75																								
75 to 80																								
80 to 85																								
85 to 90																								
90 to 95																								
95 to 100																								
100 to 105																								
Total sample																								
6.4	252	1625	1372	1805	162	550.9	918	32	279.0	432	20	110.0	50.5	5.0	17.1	730	22	162.0	46.0	16.8	29.7	50.6	20.0	29.4

[a]Based on averages per flight.

TABLE III.- Continued

(c) Airplane type 3, light piston

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5	2	7	5	324	206	265.0	108	103	105.5	118	39	78.5	29.5	13.0	22.4	103	59	81.0	34.3	29.5	32.4	39.8	29.6	30.6
5 to 10	16	112	96	2593	345	870.8	2301	116	481.1	376	42	192.6	44.0	8.4	27.5	297	96	197.1	40.1	24.0	32.9	55.3	22.1	22.6
10 to 15	26	304	278	1420	716	982.0	732	100	314.9	396	146	283.3	39.6	10.4	24.2	546	291	383.8	42.0	30.8	35.9	32.1	28.8	39.1
15 to 20	23	391	367	1402	870	1104.1	647	132	305.3	381	146	252.8	23.7	9.1	14.9	717	399	546.0	42.2	26.6	34.2	27.7	22.9	49.4
20 to 25	18	390	370	2406	898	1363.8	1163	155	421.9	459	125	289.7	21.8	5.9	13.4	838	491	652.2	30.1	23.4	31.7	30.9	21.2	47.8
25 to 30	2	51	49	1791	1584	1687.5	382	336	359.8	539	292	415.5	20.7	11.7	16.3	956	870	913.0	39.8	34.8	37.3	21.3	24.6	54.1
30 to 35	1	30	29	1597	1597	1597.0	411	411	411.0	306	306	306.0	10.2	10.2	10.2	880	880	880.0	30.3	30.3	30.3	25.7	19.2	55.1
35 to 40	3	109	106	3307	2405	2764.3	1512	944	1106.7	594	339	498.0	16.9	9.4	13.7	1201	1122	1159.7	35.3	31.2	32.8	40.0	18.0	42.0
40 to 45																								
45 to 50																								
50 to 55	1	52	51	2325	2325	2325.0	462	462	462.0	382	382	382.0	7.3	7.3	7.3	1481	1481	1481.0	29.0	29.0	29.0	19.9	16.4	63.7
55 to 60																								
60 to 65																								
65 to 70																								
70 to 75																								
75 to 80																								
80 to 85																								
85 to 90																								
90 to 95																								
95 to 100																								
100 to 105																								
Total sample																								
15.7	92	1446	1351	3307	206	1147.0	2301	100	387.2	594	39	267.9	44.0	5.9	17.0	1481	59	491.9	42.2	23.4	33.5	33.8	23.4	42.9

[a]Based on averages per flight.

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TABLE III.- Continued

(d) Airplane type 4a, heavy piston

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5	3	9	6	1173	191	534.7	983	120	412.0	50	20	39.0	15.7	10.0	13.0	140	38	83.7	46.6	36.5	41.8	77.1	7.3	15.7
5 to 10	1	7	6	813	813	813.0	473	473	473.0	104	104	104.0	14.9	14.9	14.9	236	236	236.0	39.3	39.3	39.3	58.2	12.8	29.0
10 to 15	10	121	111	960	693	850.6	314	135	215.5	276	124	185.2	27.6	8.9	15.3	529	348	449.9	48.1	37.0	40.5	25.3	21.8	52.9
15 to 20	22	380	358	1530	750	1109.0	708	120	247.9	315	126	224.9	18.5	7.0	13.0	899	443	636.2	49.9	29.5	39.1	22.4	20.3	57.4
20 to 25	6	129	123	1434	1122	1299.8	554	124	259.8	332	134	259.0	15.8	6.4	12.0	877	722	779.2	39.9	34.4	38.1	20.0	19.9	60.1
25 to 30	5	130	125	1887	1394	1585.8	488	138	257.2	294	205	251.2	11.8	7.6	9.7	1165	1019	1077.4	44.8	40.8	43.1	16.2	15.8	67.9
30 to 35	3	95	92	1927	1277	1567.0	407	208	279.3	287	214	242.0	9.0	6.9	7.6	1349	855	1145.7	43.5	28.5	37.4	16.8	14.5	68.7
35 to 40																								
40 to 45																								
45 to 50																								
50 to 55																								
55 to 60																								
60 to 65																								
65 to 70																								
70 to 75																								
75 to 80																								
80 to 85																								
85 to 90																								
90 to 100																								
100 to 105																								
Total sample																								
17.4	50	871	821	1927	191	1121.0	983	120	260.0	332	20	211.1	27.6	6.4	12.1	1349	38	649.9	49.9	28.5	39.6	23.2	18.8	58.0

[a]Based on averages per flight.

TABLE III.- Continued

(e) Airplane type 4b, heavy piston

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5	1	2	1	265	265	265.0	211	211	211.0	28	28	28.0	14.0	14.0	14.0	26	26	26.0	26.0	26.0	26.0	79.6	10.6	9.8
5 to 10	2	14	12	1302	450	876.0	820	252	536.0	232	49	140.5	29.0	8.2	20.1	250	149	199.5	35.7	29.8	33.2	61.2	16.0	22.8
10 to 15	10	126	116	1140	774	886.4	617	189	275.0	307	144	239.7	25.6	11.1	19.0	451	262	371.7	38.4	20.2	32.0	31.0	27.0	41.9
15 to 20	22	375	353	1752	794	1127.8	925	80	332.5	312	196	258.0	18.4	10.9	15.1	671	336	537.2	40.2	24.0	33.5	29.5	22.9	47.6
20 to 25	6	135	127	1995	1058	1313.8	914	105	296.5	370	266	318.0	15.4	12.5	14.1	791	618	699.3	35.4	30.9	33.0	22.6	24.2	53.2
25 to 30	5	133	128	1531	1175	1430.6	630	91	368.2	395	227	292.2	13.7	8.4	11.0	930	665	770.2	33.2	26.6	30.1	25.7	20.4	53.8
30 to 35	3	93	90	1592	1239	1428.3	286	144	218.0	297	246	279.0	9.8	8.2	9.0	1071	659	931.3	36.7	22.7	31.0	15.3	19.5	65.2
35 to 40																								
40 to 45																								
45 to 50																								
50 to 55																								
55 to 60																								
60 to 65																								
65 to 70																								
70 to 75																								
75 to 80																								
80 to 85																								
85 to 90																								
90 to 95																								
95 to 100																								
100 to 105																								
Total sample																								
17.9	49	878	827	1995	265	1122.7	925	80	318.8	395	28	256.9	29.0	8.2	14.3	1071	26	547.0	40.2	20.2	32.4	28.4	22.9	48.7

[a]Based on averages per flight.

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TABLE III.- Continued

(f) Aircraft type 4ab, heavy piston

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5	4	11	7	1173	191	467.3	983	120	361.8	50	20	36.3	15.7	10.0	13.1	140	26	69.3	46.6	26.0	39.6	77.4	7.8	14.8
5 to 10	3	21	18	1302	450	855.0	820	252	515.0	232	49	128.3	29.0	8.2	18.3	250	149	211.7	39.3	29.8	35.3	60.2	15.0	24.8
10 to 15	20	247	227	1140	693	868.5	617	135	245.3	307	124	212.5	27.6	8.9	17.2	529	262	410.8	48.1	20.2	36.2	28.3	24.5	47.3
15 to 20	44	755	711	1752	750	1118.4	925	80	290.2	315	126	241.5	18.5	7.0	14.1	899	336	586.7	49.9	24.0	36.3	25.9	21.6	52.5
20 to 25	12	264	250	1995	1058	1302.3	914	105	278.2	370	134	288.5	15.8	6.4	13.1	877	618	740.2	39.9	30.9	35.5	21.3	22.1	56.6
25 to 30	10	263	253	1887	1175	1508.2	630	91	312.7	395	227	271.7	13.7	7.6	10.3	1165	665	875.1	44.8	26.6	36.6	20.7	18.0	61.3
30 to 35	6	188	182	1927	1239	1547.7	407	144	248.7	297	214	227.2	9.8	6.9	7.3	1349	659	1038.5	43.5	22.7	34.2	16.1	16.8	67.1
35 to 40																								
40 to 45																								
45 to 50																								
50 to 55																								
55 to 60																								
60 to 65																								
65 to 70																								
70 to 75																								
75 to 80																								
80 to 85																								
85 to 90																								
90 to 95																								
95 to 100																								
100 to 105																								
Total sample																								
17.7	99	1749	1648	1995	191	1121.8	983	80	289.1	395	20	233.8	29.0	6.4	13.2	1349	26	598.9	49.9	20.2	36.0	25.8	20.8	53.4

[a]Based on averages per flight.

TABLE III.- Continued

(g) Airplane type 5a, heavy piston

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5	14	44	30	540	214	336.1	402	90	199.6	92	48	69.4	29.3	16.0	29.3	113	34	67.4	37.6	20.0	31.5	59.3	20.6	20.0
5 to 10	8	54	46	740	368	496.4	425	168	228.0	137	87	108.0	20.5	11.0	20.5	248	102	160.4	31.0	20.4	27.9	45.9	21.8	32.3
10 to 15	1	14	13	643	643	643.0	176	176	176.0	124	124	124.0	8.9	8.9	8.9	343	343	343.0	26.4	26.4	26.4	27.4	19.3	53.3
15 to 20																								
20 to 25																								
25 to 30																								
30 to 35																								
35 to 40																								
40 to 45																								
45 to 50																								
50 to 55																								
55 to 60																								
60 to 65																								
65 to 70																								
70 to 75																								
75 to 80																								
80 to 85																								
85 to 90																								
90 to 95																								
95 to 100																								
100 to 105																								
Total sample																								
4.9	23	112	89	740	214	405.3	425	90	208.4	137	48	85.2	29.3	8.9	17.5	343	34	111.7	37.6	26.4	28.9	51.4	21.0	27.6

[a]Based on averages per flight.

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TABLE III.- Continued

(h) Airplane type 5b, heavy piston

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5	26	104	78	408	312	352.1	165	93	135.5	145	116	128.0	36.3	29.0	32.0	112	74	88.5	37.3	24.6	29.5	38.5	36.4	25.1
5 to 10	37	229	192	564	285	376.9	211	72	124.0	204	60	111.4	34.0	11.2	18.5	216	94	141.5	31.5	18.8	27.3	32.9	29.5	37.6
10 to 15	24	280	256	1308	425	740.1	751	95	228.6	479	71	214.8	34.2	7.1	18.4	446	195	296.7	35.0	19.5	27.8	30.9	29.0	40.1
15 to 20	9	150	141	1821	759	1176.7	821	164	419.7	550	134	286.8	28.9	7.9	17.2	664	354	470.2	38.9	22.1	30.0	35.7	24.4	40.0
20 to 25	5	109	104	2038	1122	1665.0	902	255	491.2	838	230	486.0	41.9	11.5	22.3	778	488	687.8	40.9	25.7	33.1	29.5	29.2	41.3
25 to 30																								
30 to 35	1	34	33	1232	1232	1232	121	121	121.0	255	255	255.0	7.5	7.5	7.5	856	856	856.0	25.9	25.9	25.9	9.8	20.7	69.5
35 to 40	1	35	34	3207	3207	3207	1611	1611	1611.0	448	448	448.0	12.8	12.8	12.8	1148	1148	1148.0	33.8	33.8	33.8	50.2	14.0	35.8
40 to 45																								
45 to 50																								
50 to 55																								
55 to 60																								
60 to 65																								
65 to 70																								
70 to 75																								
75 to 80																								
80 to 85																								
85 to 90																								
90 to 95																								
95 to 100																								
100 to 105																								
Total sample																								
9.1	103	941	838	3207	285	623.5	1611	72	209.3	838	60	177.9	41.9	7.1	19.5	1148	74	236.3	40.9	18.8	29.0	33.6	28.5	37.9

[a]Based on averages per flight.

TABLE III.- Continued

(i) Airplane type 5ab, heavy piston

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5	40	148	108	540	214	346.6	402	90	158.0	145	48	107.5	36.3	16.0	29.1	113	34	81.2	37.6	20.0	30.1	45.6	31.0	23.4
5 to 10	45	283	238	740	285	398.1	425	72	142.5	204	60	110.8	34.0	11.0	17.6	248	94	144.9	31.5	18.8	27.4	35.8	27.8	36.4
10 to 15	25	294	269	1308	425	736.2	751	95	226.5	479	71	211.2	34.2	7.1	18.0	446	195	298.6	35.0	19.5	27.7	30.8	28.7	40.6
15 to 20	9	150	141	1821	759	1176.7	821	164	419.7	550	134	296.8	28.9	7.9	17.2	664	354	478.6	38.9	22.1	30.0	35.7	24.4	40.0
20 to 25	5	109	104	2038	1122	1665.0	902	255	491.2	838	230	486.0	41.9	11.5	22.3	778	488	687.8	40.9	25.7	33.1	29.5	29.2	41.3
25 to 30																								
30 to 35	1	34	33	1232	1232	1232	121	121	121.0	255	255	255.0	7.5	7.5	7.5	856	856	856.0	25.9	25.9	25.9	9.8	20.7	69.5
35 to 40	1	35	34	3207		3207	1611	1611	1611.0	448	448	448.0	12.8	12.8	12.8	1148	1148	1148.0	33.8	33.8	33.8	50.2	14.0	35.8
40 to 45																								
45 to 50																								
50 to 55																								
55 to 60																								
60 to 65																								
65 to 70																								
70 to 75																								
75 to 80																								
80 to 85																								
85 to 90																								
90 to 95																								
95 to 100																								
100 to 105																								
Total sample																								
8.4	126	1053	927	3207	214	583.6	1611	72	209.2	838	48	160.9	41.9	7.1	19.3	1148	34	213.5	40.9	18.8	29.0	35.8	27.6	36.6

[a]Based on averages per flight.

BEST DOCUMENT AVAILABLE

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TABLE III.- Continued

(j) Airplane type 6a, heavy piston

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5	1	4	3	324	324	324.0	192	192	192.0	18	18	18.0	4.5	4.5	4.5	114	114	114.0	38.0	38.0	38.0	59.3	5.6	35.2
5 to 10	27	204	177	821	321	555.4	391	67	191.7	360	45	177.6	40.0	5.6	23.5	270	109	186.1	35.0	17.6	28.4	34.5	32.0	33.5
10 to 15	55	643	588	927	463	705.3	429	80	181.1	374	88	223.2	37.4	7.8	19.1	435	178	300.9	39.9	19.8	28.1	25.7	31.6	42.7
15 to 20	28	466	437	1780	570	863.7	893	49	189.1	461	147	266.2	30.7	8.6	16.0	549	274	408.5	38.2	18.8	26.2	21.9	30.8	47.3
20 to 25	19	421	402	1391	748	1040.8	288	58	186.0	499	138	310.4	23.8	6.6	14.0	681	301	544.4	30.3	15.8	25.7	17.9	29.8	52.3
25 to 30	11	291	280	1574	1064	1208.6	481	88	253.4	312	198	266.7	12.3	7.9	10.1	835	525	688.5	32.1	21.0	27.1	21.0	22.1	57.0
30 to 35	6	193	186	2359	1050	1476.2	974	88	319.8	470	255	377.2	15.7	7.7	11.7	1018	587	779.2	31.8	19.6	25.1	21.7	25.6	52.8
35 to 40	2	72	69	1890	1590	1740.0	544	184	364.0	504	420	462.0	14.4	11.7	12.8	986	842	914.0	28.2	24.8	26.5	20.9	26.6	52.5
40 to 45	1	44	43	1638	1638	1638.0	246	246	246.0	390	390	390.0	8.9	8.9	8.9	1002	1002	1002.0	23.3	23.3	23.3	15.0	23.8	61.2
45 to 50																								
50 to 55																								
55 to 60	1	57	56	2241	2241	2241.0	360	360	360.0	495	495	495.0	8.7	8.7	8.7	1386	1386	1386.0	24.8	24.8	24.8	16.1	22.1	61.8
60 to 65																								
65 to 70																								
70 to 75																								
75 to 80																								
80 to 85																								
85 to 90																								
90 to 95																								
95 to 100																								
100 to 105																								
Total sample																								
15.9	151	2395	2241	2359	321	844.9	974	49	200.0	504	18	248.0	40.0	4.5	15.6	1386	109	396.9	39.9	15.8	26.7	23.7	29.4	47.0

[a]Based on averages per flight.

TABLE III.- Continued

(k) Airplane type 6b, heavy piston

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5																								
5 to 10	30	211	181	884	511	640.3	536	228	319.7	222	121	175.2	34.3	16.8	24.9	218	94	145.4	27.5	18.0	24.1	49.9	27.4	22.7
10 to 15	88	1046	957	1262	527	712.8	755	119	302.0	208	110	163.8	20.8	9.9	13.8	356	184	247.0	29.6	17.7	22.7	42.4	23.0	34.7
15 to 20	13	206	193	1638	704	945.4	940	151	379.5	253	171	216.1	16.9	10.8	13.6	485	277	349.8	32.2	18.5	23.6	40.1	22.9	37.0
20 to 25																								
25 to 30																								
30 to 35																								
35 to 40																								
40 to 45																								
45 to 50																								
50 to 55																								
55 to 60																								
60 to 65																								
65 to 70																								
70 to 75																								
75 to 80																								
80 to 85																								
85 to 90																								
90 to 95																								
95 to 100																								
100 to 105																								
Total sample																								
11.2	131	1463	1331	1638	511	719.3	940	119	313.8	253	110	171.6	34.3	9.9	15.4	485	94	234.0	32.2	17.7	23.0	43.6	23.9	32.5

[a]Based on averages per flight.

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TABLE III.- Continued

(1) Airplane type 6ab, heavy piston

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5	1	4	3	324	324	324.0	192	192	192.0	18	18	18.0	4.5	4.5	4.5	114	114	114.0	38.0	38.0	38.0	59.3	5.6	35.2
5 to 10	57	415	358	884	321	600.1	536	67	259.1	360	45	176.4	40.0	5.6	24.2	270	94	164.7	35.0	17.6	26.2	43.2	29.4	27.4
10 to 15	143	1689	1545	1262	463	709.9	755	80	255.1	374	88	186.6	37.4	7.8	15.8	435	178	267.8	39.9	17.7	24.8	36.0	26.3	37.7
15 to 20	41	672	630	1780	570	889.6	940	49	249.4	461	147	250.3	30.7	8.6	15.3	549	274	391.4	38.2	18.5	25.4	28.0	28.1	43.8
20 to 25	19	421	402	1391	748	1040.8	288	58	186.0	499	138	310.4	23.8	6.6	14.8	681	301	544.4	30.3	15.9	25.7	17.9	29.8	52.3
25 to 30	11	291	280	1574	1064	1208.6	481	88	253.4	312	198	266.7	12.3	7.9	10.1	835	525	680.5	32.1	21.0	27.1	21.0	22.1	57.0
30 to 35	6	193	186	2359	1050	1476.2	974	88	319.8	470	255	377.2	15.7	7.7	11.7	1018	587	792.2	31.8	19.6	25.1	21.7	25.6	52.8
35 to 40	2	72	69	1890	1590	1740.0	544	184	364.0	504	420	462.0	14.4	11.7	12.8	986	842	914.0	28.2	24.8	26.5	20.9	26.6	52.5
40 to 45	1	44	43	1638	1638	1638.0	246	246	246.0	390	390	390.0	8.9	8.9	8.9	1002	1002	1002.0	23.3	23.3	23.3	15.0	23.8	61.2
45 to 50																								
50 to 55																								
55 to 60	1	57	56	2241	2241	2241.0	360	360	360.0	495	495	495.0	8.7	8.7	8.7	1386	1386	1386.0	24.8	24.8	24.8	16.1	22.1	61.8
60 to 65																								
65 to 70																								
70 to 75																								
75 to 80																								
80 to 85																								
85 to 90																								
90 to 95																								
95 to 100																								
100 to 105																								
Total sample																								
13.7	282	3858	3572	2359	321	786.6	974	49	252.8	504	18	212.5	40.0	4.5	15.5	1386	94	321.2	39.9	15.8	25.4	32.1	27.0	40.8

[a]Based on averages per flight.

TABLE III.- Continued

(m) Airplane type 7a, heavy turbine

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5	26	91	65	336	184	242.4	193	56	108.7	100	41	81.2	33.3	10.3	23.2	80	33	52.5	26.6	15.3	21.0	44.8	33.5	21.7
5 to 10	37	255	218	894	219	421.1	561	73	160.4	206	53	129.6	28.0	10.5	18.8	201	68	131.1	34.8	16.8	22.2	38.1	30.8	31.1
10 to 15	24	276	252	972	450	620.6	457	93	162.3	324	124	206.0	24.9	10.3	17.9	346	185	252.3	30.1	18.6	24.0	26.1	33.2	40.7
15 to 20	9	150	141	1188	630	852.7	475	50	230.3	336	195	249.2	19.7	13.0	15.0	474	332	373.1	27.9	21.8	23.8	27.8	29.2	43.8
20 to 25	5	107	102	1202	714	951.4	368	96	187.6	628	168	296.4	28.5	8.4	13.9	540	411	467.4	24.9	21.6	22.9	19.7	31.2	49.1
25 to 30																								
30 to 35	1	32	31	1212	1212	1212.0	133	133	133.0	448	448	448.0	14.0	14.0	14.0	631	631	631.0	20.4	20.4	20.4	11.0	37.0	52.1
35 to 40	1	37	36	1350	1350	1350.0	135	135	135.0	568	568	568.0	15.4	15.4	15.4	647	647	647.0	18.0	18.0	18.0	10.0	42.1	47.9
40 to 45																								
45 to 50																								
50 to 55																								
55 to 60																								
60 to 65																								
65 to 70																								
70 to 75																								
75 to 80																								
80 to 85																								
85 to 90																								
90 to 95																								
95 to 100																								
100 to 105																								
Total sample 9.2	103	948	845	1350	184	502.6	567	50	154.7	628	41	161.1	33.3	8.4	17.5	647	33	186.8	34.8	15.3	22.8	30.8	32.0	37.2

[a]Based on averages per flight.

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TABLE III.- Continued

(a) Airplane type 7b, heavy turbine

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5	26	100	74	450	210	276.3	390	64	124.3	121	20	74.7	37.3	6.7	19.4	101	28	77.3	33.7	21.7	27.1	45.0	27.0	28.0
5 to 10	37	236	198	564	246	380.5	282	70	128.3	186	52	118.0	27.0	10.4	18.5	202	88	134.2	34.0	19.4	25.1	33.7	31.0	35.3
10 to 15	24	276	252	1031	396	680.2	616	69	175.3	290	89	168.0	26.4	7.8	14.6	339	187	256.8	30.0	20.0	24.5	29.2	28.0	42.8
15 to 20	9	151	142	1266	534	835.9	637	67	207.4	382	96	184.1	20.1	6.0	11.0	520	337	444.3	32.5	22.5	28.2	24.8	22.0	53.1
20 to 25	5	185	180	1048	819	927.0	135	73	109.6	446	165	323.8	22.3	7.2	15.4	536	443	494.6	26.1	23.3	24.7	11.8	34.8	53.4
25 to 30																								
30 to 35	1	33	32	1035	1035	1035.0	84	84	84.0	227	227	227.0	6.9	6.9	6.9	724	724	724.0	22.6	22.6	22.6	8.1	21.9	70.0
35 to 40	1	37	36	1626	1626	1626.0	246	246	246.0	510	510	510.0	13.8	13.8	13.8	870	870	870.0	24.2	24.2	24.2	15.1	31.4	53.5
40 to 45																								
45 to 50																								
50 to 55																								
55 to 60																								
60 to 65																								
65 to 70																								
70 to 75																								
75 to 80																								
80 to 85																								
85 to 90																								
90 to 95																								
95 to 100																								
100 to 105																								
Total sample																								
9.1	103	938	934	1626	210	490.2	637	49	145.0	510	20	139.3	37.3	6.0	15.3	870	28	285.9	34.0	19.4	25.4	29.6	29.4	42.0

[a]Based on averages per flight.

TABLE III.- Continued

(o) Airplane type 7ab, heavy turbine

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5	52	191	139	450	184	259.4	390	56	116.4	121	20	78.0	37.3	6.7	21.2	101	28	64.9	33.7	15.3	24.3	44.9	30.1	25.0
5 to 10	74	491	416	894	219	400.8	567	70	144.4	206	52	123.8	28.0	10.4	18.7	201	68	132.6	34.8	16.8	23.6	36.0	30.9	33.1
10 to 15	48	552	504	1031	396	610.4	616	49	168.8	324	89	187.0	26.4	7.8	16.3	346	185	254.6	30.1	18.6	24.2	27.7	30.6	41.7
15 to 20	18	301	283	1266	534	844.3	637	50	218.9	382	96	216.7	20.1	6.0	13.0	520	332	408.7	32.5	21.8	26.0	25.9	25.7	48.4
20 to 25	10	212	202	1202	714	939.2	360	73	148.6	628	165	309.6	28.5	7.2	14.6	540	411	481.0	26.1	21.6	23.8	15.8	33.0	51.2
25 to 30																								
30 to 35	2	65	63	1212	1035	1057.5	133	84	108.5	448	227	248.5	14.0	6.9	7.8	724	631	677.5	22.6	20.4	21.5	8.8	23.5	67.7
35 to 40	2	74	72	1626	1350	1488.0	246	135	190.5	568	510	539.0	15.4	13.8	14.6	870	647	758.5	24.2	18.0	21.1	12.8	36.2	51.0
40 to 45																								
45 to 50																								
50 to 55																								
55 to 60																								
60 to 65																								
65 to 70																								
70 to 75																								
75 to 80																								
80 to 85																								
85 to 90																								
90 to 95																								
95 to 100																								
100 to 105																								
Total sample																								
9.2	206	1886	1679	1626	184	496.4	637	49	149.8	628	20	150.2	37.3	6.0	16.4	870	28	196.4	34.8	15.3	24.1	30.2	30.3	39.6

[a]Based on averages per flight.

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TABLE III.- Continued

(p) Airplane type 8a, heavy turbine

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5	18	65	47	708	264	348.3	398	106	166.4	199	42	111.4	49.8	14.0	30.9	111	48	70.4	37.0	16.0	27.0	47.8	32.0	20.2
5 to 10	20	117	97	576	299	406.8	246	93	157.7	174	68	138.8	30.0	13.6	23.7	170	62	110.4	34.8	15.5	22.8	38.8	34.1	27.1
10 to 15	11	135	124	1353	477	906.5	790	180	431.7	441	104	195.8	40.1	7.6	16.0	423	151	278.9	34.5	16.8	24.7	47.6	21.6	30.8
15 to 20	11	194	183	1380	636	1030.5	568	105	312.9	466	167	354.7	27.3	9.3	20.1	470	261	362.8	26.1	16.3	21.8	30.4	34.4	35.2
20 to 25	8	180	171	1580	911	1185.8	578	131	365.4	535	143	331.3	22.3	6.8	14.7	585	408	489.1	25.6	20.4	22.9	30.8	27.9	41.3
25 to 30	11	297	284	1959	912	1307.6	1142	131	369.2	507	243	369.0	17.4	9.7	13.7	679	489	569.5	27.2	16.9	22.1	28.2	28.2	43.5
30 to 35	8	257	249	1953	1094	1454.4	917	149	362.9	567	298	410.1	16.7	8.8	12.8	839	536	681.4	27.0	17.9	21.9	25.0	28.2	46.9
35 to 40	6	224	214	2084	1566	1703.7	816	314	487.5	568	359	453.7	15.4	9.7	12.2	909	596	762.5	25.3	17.0	21.4	28.6	26.6	44.8
40 to 45	2	83	81	1775	1321	1548.0	414	261	337.5	401	268	334.5	9.3	6.7	8.1	960	792	876.0	22.9	20.3	21.6	21.8	21.6	56.6
45 to 50	3	140	137	1787	1613	1700.3	392	90	252.3	546	342	444.3	12.1	7.1	9.4	1084	849	1003.7	23.4	19.3	22.0	14.8	26.1	59.0
50 to 55	2	107	105	2376	2099	2237.5	520	316	418.0	575	385	480.0	10.8	7.1	9.0	1471	1208	1339.5	27.8	23.2	25.5	18.7	21.5	59.9
55 to 60																								
60 to 65																								
65 to 70																								
70 to 75																								
75 to 80																								
80 to 85																								
85 to 90																								
90 to 100																								
100 to 105																								
Total sample																								
18.0	100	1799	1692	2376	264	941.1	1142	90	294.2	568	42	265.1	49.8	6.7	14.7	1471	48	381.8	37.0	15.5	22.6	31.3	28.2	40.6

[a]Based on averages per flight.

TABLE III.- Continued

(q) Airplane type 8b, heavy turbine

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5																								
5 to 10																								
10 to 15	1	13	12	1882	1882	1882.0	1276	1276	1276.0	243	243	243.0	18.7	18.7	18.7	363	363	363.0	30.3	30.3	30.3	67.8	12.9	19.3
15 to 20	11	188	177	2761	919	2006.2	1936	160	1140.0	763	190	408.3	42.4	10.0	23.9	554	388	457.8	32.5	26.4	28.5	56.8	20.4	22.8
20 to 25	8	179	171	2454	1298	2022.3	1382	372	1022.1	583	122	409.9	27.8	5.3	18.3	675	441	490.3	31.7	21.0	27.6	50.5	20.3	29.2
25 to 30	11	290	278	6059	1959	2756.4	4817	956	1549.4	625	253	443.2	25.0	8.7	16.8	1252	541	763.8	52.2	22.5	30.2	56.2	16.1	27.7
30 to 35	8	250	240	3234	1567	2332.3	1958	568	1128.3	710	200	207.6	22.9	6.7	13.0	956	668	796.4	31.7	22.0	26.5	48.4	17.5	34.1
35 to 40	6	222	216	4384	1446	2784.0	2791	251	1315.7	911	300	509.5	25.3	7.9	13.8	1121	817	958.8	31.1	24.0	26.6	47.3	18.3	34.4
40 to 45	2	83	81	3133	2863	2998.0	1381	1182	1281.5	821	681	751.0	19.1	17.0	18.1	1000	931	965.5	25.6	22.2	23.8	42.7	25.1	32.2
45 to 50	3	139	136	2961	2803	2885.3	1038	939	976.7	1029	647	866.0	22.9	14.4	18.7	1276	910	1042.7	29.0	19.6	23.0	33.8	30.0	36.1
50 to 55	1	54	53	3290	3290	3290.0	1351	1351	1351.0	470	470	470.0	8.7	8.7	8.7	1469	1469	1469.0	27.7	27.7	27.7	41.1	14.3	44.7
55 to 60	1	55	54	3146	3146	3146.0	960	960	960.0	644	644	644.0	11.7	11.7	11.7	1542	1542	1542.0	28.6	28.6	28.6	30.5	20.5	49.0
60 to 65																								
65 to 70																								
70 to 75																								
75 to 80																								
80 to 85																								
85 to 90																								
90 to 95																								
95 to 100																								
100 to 105																								
Total sample																								
28.3	52	1473	1418	6059	919	2440.3	4817	160	1226.2	1029	122	469.6	42.4	5.3	16.6	1542	363	744.6	52.2	19.6	27.3	50.2	19.2	30.5

[a]Based on averages per flight.

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TABLE III.- Concluded

(r) Airplane type 6ab, heavy turbine

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5	18	65	47	708	264	348.3	398	106	166.4	199	42	111.4	49.8	14.0	30.9	111	48	78.4	37.0	16.0	27.0	47.8	32.0	20.2
5 to 10	20	117	97	576	299	406.8	246	93	157.7	174	68	138.8	30.0	13.6	23.7	170	62	110.4	34.8	15.5	22.8	38.8	34.1	27.1
10 to 15	12	148	136	1882	477	987.8	1276	180	502.1	441	104	199.8	40.1	7.6	16.2	423	151	285.9	34.5	16.8	25.2	50.8	20.2	28.9
15 to 20	22	382	360	2761	636	1518.4	1936	105	726.5	763	167	381.5	42.4	9.3	22.0	554	261	410.3	32.5	16.3	25.1	47.8	25.1	27.0
20 to 25	16	359	342	2454	911	1604.0	1382	131	693.8	583	122	370.6	27.8	5.3	16.5	675	408	539.7	31.7	20.4	25.2	43.3	23.1	33.6
25 to 30	22	587	562	6059	912	2032.0	4817	131	959.3	625	243	406.1	25.0	8.7	15.2	1252	489	666.6	52.2	16.9	26.1	47.2	20.0	32.8
30 to 35	16	507	489	3234	1094	1893.3	1958	149	745.6	710	200	408.9	22.9	6.7	12.9	956	536	738.9	31.7	17.9	24.2	39.4	21.6	39.0
35 to 40	12	446	430	4384	1446	2243.8	2791	251	901.6	911	300	481.6	25.3	7.9	13.0	1121	596	860.7	31.1	17.0	24.0	40.2	21.5	38.4
40 to 45	4	166	162	3133	1321	2273.0	1381	261	809.5	821	268	542.8	19.1	6.7	13.1	1000	792	920.8	25.6	20.3	22.7	35.6	23.9	40.5
45 to 50	6	279	273	2961	1613	2292.8	1038	90	614.5	1029	342	655.2	22.9	7.1	14.1	1276	849	1023.2	29.0	19.3	22.5	26.8	28.6	44.6
50 to 55	3	161	158	3290	2099	2588.3	1351	316	729.0	575	385	476.7	10.8	7.1	8.9	1471	1208	1382.7	27.8	23.2	26.3	28.2	18.4	53.4
55 to 60	1	55	54	3146	3146	3146.0	960	960	960.0	644	644	644.0	11.7	11.7	11.7	1542	1542	1542.0	28.6	28.6	28.6	30.5	20.5	49.0
60 to 65																								
65 to 70																								
70 to 75																								
75 to 80																								
80 to 85																								
85 to 90																								
90 to 95																								
95 to 100																								
100 to 105																								
Total sample																								
21.5	152	3272	3110	6059	264	1454.0	4817	90	613.0	1029	42	335.1	49.8	5.3	15.6	1542	48	505.9	52.2	15.5	24.7	42.2	23.0	34.8

[a]Based on averages per flight.

TABLE IV.- SUMMARY OF OPERATIONAL DATA FROM THREE CLASSES OF AGRICULTURAL AIRPLANES

(a) Class A, light piston

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5	106	379	273	708	162	363.0	586	32	216.8	202	20	73.9	50.5	6.7	20.7	113	22	72.2	46.0	20.0	28.1	59.7	20.4	19.9
5 to 10	134	905	770	2593	282	626.5	2301	90	318.6	376	25	131.1	44.0	5.0	19.4	310	67	176.7	44.6	16.8	30.7	50.9	20.9	28.2
10 to 15	64	752	688	1805	491	895.0	918	100	330.5	432	112	214.6	39.6	8.1	18.3	546	210	349.9	42.0	16.9	32.6	36.9	24.0	39.1
15 to 20	30	514	482	1402	830	1131.7	877	132	366.9	381	135	238.8	23.7	8.4	13.9	717	348	529.9	42.2	24.8	32.7	32.4	21.1	46.5
20 to 25	23	500	473	3113	898	1442.5	2045	155	496.7	703	118	303.0	33.5	4.9	13.0	838	471	642.7	32.1	23.4	31.3	34.4	21.0	44.6
25 to 30	8	211	203	3367	1125	1784.9	2013	48	421.1	1009	195	605.9	34.8	7.5	23.0	956	538	757.9	39.8	21.5	29.9	23.6	33.9	42.5
30 to 35	7	220	213	2530	1414	1941.3	799	83	496.9	884	306	645.3	26.7	10.2	20.5	883	680	799.1	30.3	21.9	26.3	25.6	33.2	41.2
35 to 40	7	256	248	3307	1546	2247.9	1512	117	622.1	1078	336	567.1	29.9	8.6	15.5	1201	914	1058.6	35.3	25.1	29.9	27.7	25.2	47.1
40 to 45	8	345	336	3761	1770	2494.3	1216	184	420.4	1353	587	948.4	31.6	11.8	22.0	1272	960	1125.5	29.6	22.9	26.8	16.9	38.0	45.1
45 to 50	6	283	277	4051	1613	2923.0	1274	104	326.3	1617	455	1331.3	34.4	10.1	28.2	1659	1050	1265.3	36.1	23.9	27.4	11.2	45.6	43.3
50 to 55	5	262	256	3002	2325	2805.2	536	177	307.6	1461	382	1145.6	27.6	7.3	21.9	1361	1257	1352.0	29.0	24.5	26.4	11.0	40.8	48.2
55 to 60	1	59	58	3437	3437	3437.0	489	489	489.0	1311	1311	1311.0	22.2	22.2	22.2	1637	1637	1637.0	28.2	28.2	28.2	14.2	38.1	47.6
60 to 65	6	376	366	3817	2231	3164.0	1176	96	330.5	1705	757	1291.2	28.0	12.0	20.6	1758	1378	1542.3	28.4	22.2	25.3	10.4	40.8	48.7
65 to 70	4	271	266	3806	3346	3353.3	582	206	364.8	1637	938	1377.5	23.7	13.6	20.3	1963	1673	1791.0	28.9	25.3	26.9	10.3	39.0	50.7
70 to 75	2	140	138	3782	3160	3471.0	285	163	224.0	1645	1386	1515.5	23.5	19.8	21.7	1852	1611	1731.5	26.8	23.3	25.1	6.5	43.7	49.9
75 to 80	4	304	297	4517	3025	3934.5	600	293	444.5	2178	1051	1648.5	29.0	13.6	21.7	2126	1681	1841.5	28.3	22.7	24.8	11.3	41.9	46.8
80 to 85	3	248	243	5120	3698	4174.3	779	369	528.0	2285	1005	1484.3	27.5	12.4	18.0	2399	2010	2162.0	29.3	24.2	26.7	12.6	35.6	51.8
85 to 90	2	172	169	6200	4727	5463.5	2400	578	1489.0	1937	1594	1765.5	22.3	18.8	20.5	2212	2206	2209.0	26.3	26.0	26.1	27.3	32.3	40.4
90 to 95	4	370	364	5203	4360	4751.3	1125	474	850.8	1528	1283	1425.3	16.4	14.9	15.4	2596	2153	2475.3	28.7	23.7	27.2	17.9	30.0	52.1
95 to 100	2	193	188	5095	4228	4661.5	610	285	447.5	2120	1590	1855.0	21.9	16.6	19.2	2365	2353	2359.0	25.2	25.0	25.1	9.6	39.8	50.6
100 to 105	2	202	200	5816	5218	5517.0	1374	380	877.0	2183	1720	1951.5	21.6	17.0	19.3	2722	2655	2688.5	27.2	26.6	26.9	15.9	35.4	48.7
Total sample																								
16.3	428	6962	6508	6200	162	1084.1	2400	32	336.7	2285	20	311.7	50.5	4.9	19.2	2722	22	435.7	46.0	16.8	28.7	31.1	28.8	40.2

[a]Based on averages per flight.

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TABLE IV.- Continued

(b) Class B, heavy piston

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5	45	163	118	1173	191	356.8	983	90	176.8	145	18	99.2	36.3	4.5	27.4	140	26	80.8	46.6	20.0	30.8	49.6	27.8	22.7
5 to 10	105	719	614	1302	285	520.8	820	67	216.4	360	45	146.9	40.0	5.6	21.4	270	94	157.5	39.3	18.8	26.9	41.6	28.2	30.2
10 to 15	188	2230	2041	1308	425	730.3	755	80	250.6	479	71	192.7	37.4	7.1	16.2	529	178	287.1	48.1	17.7	26.4	34.3	26.4	39.3
15 to 20	94	1577	1482	1821	570	1024.2	940	49	284.8	550	126	249.7	30.7	7.0	14.9	899	274	489.7	49.9	18.5	31.1	27.8	24.4	47.8
20 to 25	36	794	756	2038	748	1216.2	914	58	259.1	838	134	327.5	41.9	6.4	14.8	877	301	629.6	40.9	15.8	30.0	21.3	26.9	51.8
25 to 30	21	554	533	1887	1064	1351.3	630	88	281.6	395	198	269.1	13.7	7.6	10.2	1165	525	800.6	44.8	21.0	31.5	20.8	19.9	59.3
30 to 35	13	415	401	2359	1050	1490.4	974	88	271.7	470	214	313.9	15.7	6.9	9.8	1349	587	904.7	43.5	19.6	29.3	18.2	21.1	60.7
35 to 40	3	107	103	3207	1590	2229.0	1611	184	779.7	504	420	457.3	14.4	11.7	12.8	1148	842	992.0	33.8	24.8	28.9	35.0	20.5	44.5
40 to 45	1	44	43	1638	1638	1638.0	246	246	246.0	390	390	390.0	8.9	8.9	8.9	1002	1002	1002.0	23.3	23.3	23.3	15.0	23.8	61.2
45 to 50																								
50 to 55																								
55 to 60	1	57	56	2241	2241	2241.0	360	360	360.0	495	495	495.0	8.7	8.7	8.7	1386	1386	1386.0	24.8	24.8	24.8	16.1	22.1	61.8
60 to 65																								
65 to 70																								
70 to 75																								
75 to 80																								
80 to 85																								
85 to 90																								
90 to 95																								
95 to 100																								
100 to 105																								
Total sample																								
13.1	507	6660	6147	3207	191	801.6	1611	49	249.1	838	18	203.8	41.9	4.5	15.5	1386	26	348.7	49.9	15.8	28.8	31.1	25.4	43.5

[a]Based on averages per flight.

TABLE IV.- Concluded

(c) Class C, heavy turbine

Spreading runs per flight	Number of flights	Number of spreading runs	Number of turns between runs	Time per flight, sec			Ferry time per flight, sec			Spreading time per flight, sec			Time per spreading run, sec			Turning time per flight, sec			Time per turn, sec			Percent flight time for -		
				Max	Min	Av	Max	Min	Av	Max	Min	Av	Max (a)	Min (a)	Av	Max	Min	Av	Max (a)	Min (a)	Av	Ferry	Spreading	Turns
0 to 5	70	256	186	708	184	282.2	398	56	129.3	199	20	86.6	49.8	6.7	23.7	111	28	66.3	37.0	15.3	25.0	45.8	30.7	23.5
5 to 10	94	608	513	894	219	482.1	567	70	147.2	206	52	127.0	30.0	10.4	19.6	201	62	127.9	34.8	15.5	23.4	36.6	31.6	31.8
10 to 15	60	700	640	1882	396	685.9	1276	49	235.5	441	89	189.6	40.1	7.6	16.2	423	151	268.9	34.5	16.9	24.5	34.3	27.6	38.0
15 to 20	40	683	643	2761	534	1215.0	1936	50	498.1	763	96	307.4	42.4	6.0	18.0	554	261	409.6	32.5	16.3	25.5	41.0	25.3	33.7
20 to 25	26	571	544	2454	714	1348.3	1382	73	484.1	628	165	347.1	28.5	5.3	15.8	675	411	517.1	31.7	20.4	24.7	35.9	25.7	38.4
25 to 30	22	587	562	6059	912	2032.0	4817	131	959.3	635	243	406.1	25.0	8.7	15.2	1252	489	686.6	52.2	16.9	26.1	47.2	20.0	32.8
30 to 35	18	572	552	3234	1035	1807.8	1958	84	674.8	710	200	488.9	22.9	6.7	12.6	956	536	732.1	31.7	17.9	24.0	37.3	22.2	40.5
35 to 40	14	520	502	4384	1350	2135.9	2791	135	800.0	911	380	489.8	25.3	7.9	13.2	1121	596	846.1	31.1	17.0	23.6	37.5	22.9	39.6
40 to 45	4	166	162	3133	1321	2273.0	1381	261	809.5	821	268	542.8	19.1	6.7	13.1	1000	792	920.8	25.6	20.3	22.7	35.6	23.9	40.5
45 to 50	6	279	273	2961	1613	2292.8	1038	90	614.5	1029	342	655.2	22.9	7.1	14.1	1276	849	1033.2	29.0	19.3	22.5	26.8	28.6	44.6
50 to 55	3	161	158	3290	2099	2588.3	1351	316	729.0	575	385	476.7	10.8	7.1	8.9	1471	1208	1382.7	27.8	23.2	26.3	28.2	18.4	53.4
55 to 60	1	55	54	3146	3146	3146.0	960	960	960.0	644	644	644.0	11.7	11.7	11.7	1542	1542	1542.0	28.6	28.6	28.6	30.5	20.5	49.0
60 to 65																								
65 to 70																								
70 to 75																								
75 to 80																								
80 to 85																								
85 to 90																								
90 to 95																								
95 to 100																								
100 to 105																								
Total sample																								
14.4	358	5158	4789	6059	184	903.0	4817	49	346.5	1029	32	238.7	40.8	5.3	15.9	1542	28	327.8	52.2	15.3	24.5	38.4	25.3	36.3

[a]Based on averages per flight.

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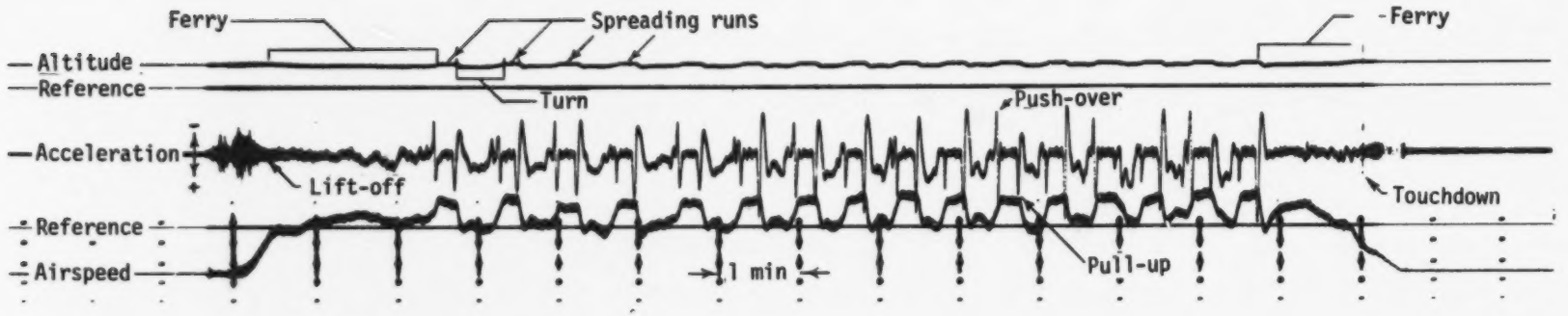

Figure 1.- Example of agricultural flight on VGH record.

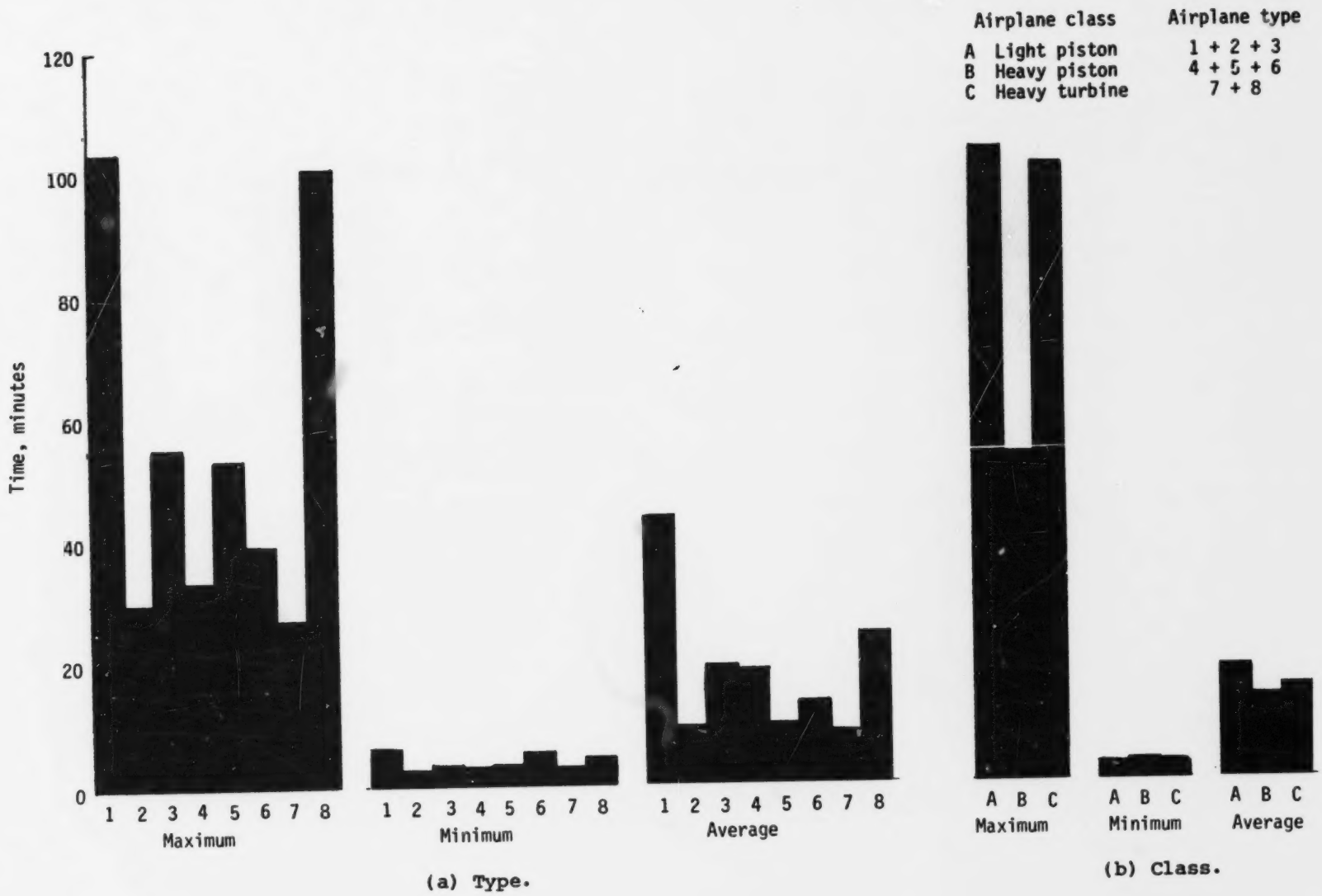

Figure 2.- Flight time for different airplane types and classes.

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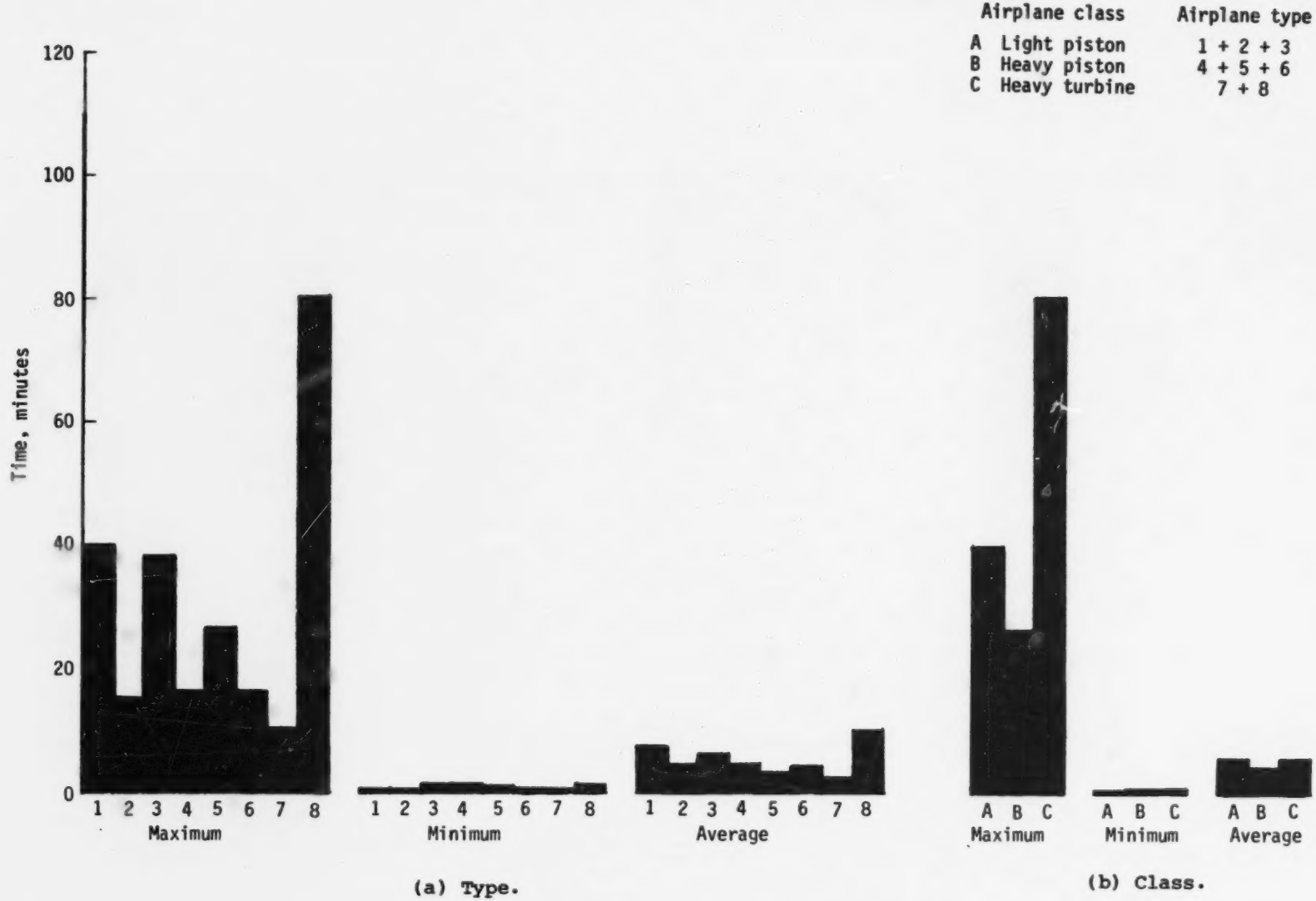

Figure 3.- Ferry time per flight for different airplane types and classes.

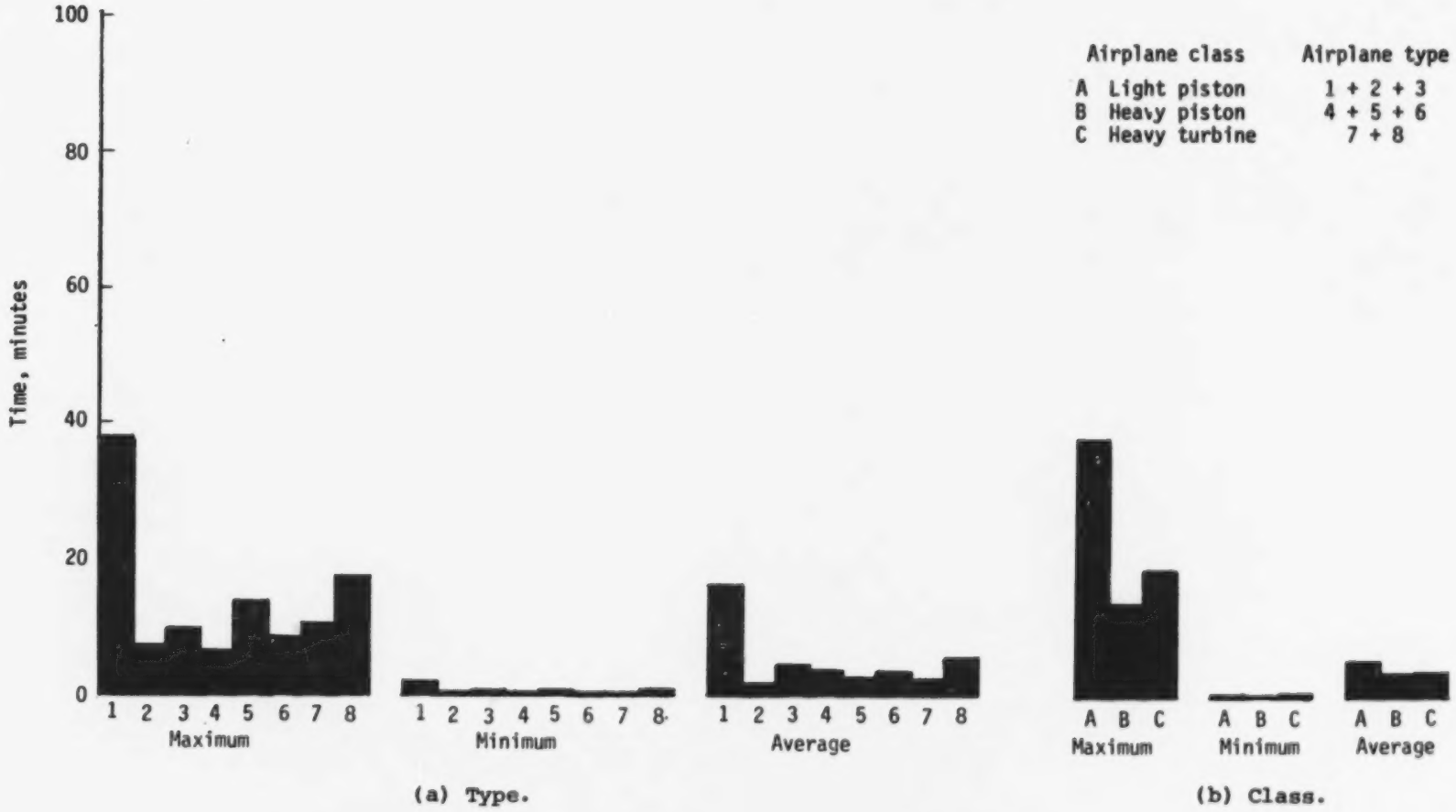

Figure 4.- Spreading time per flight for different airplane types and classes.

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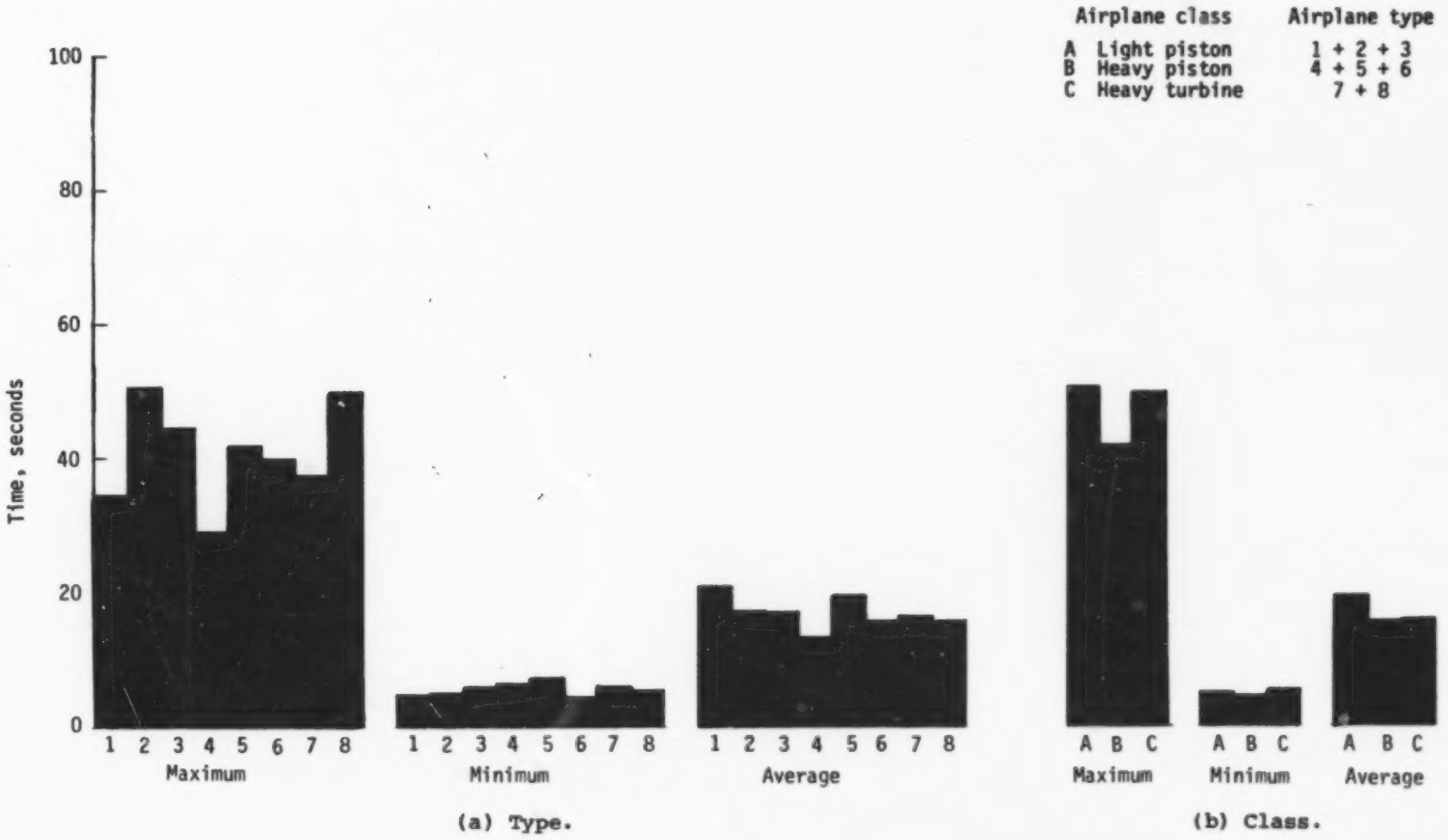

Figure 5.- Spreading time per run for different airplane types and classes. Maximum and minimum values are based on averages per flight.

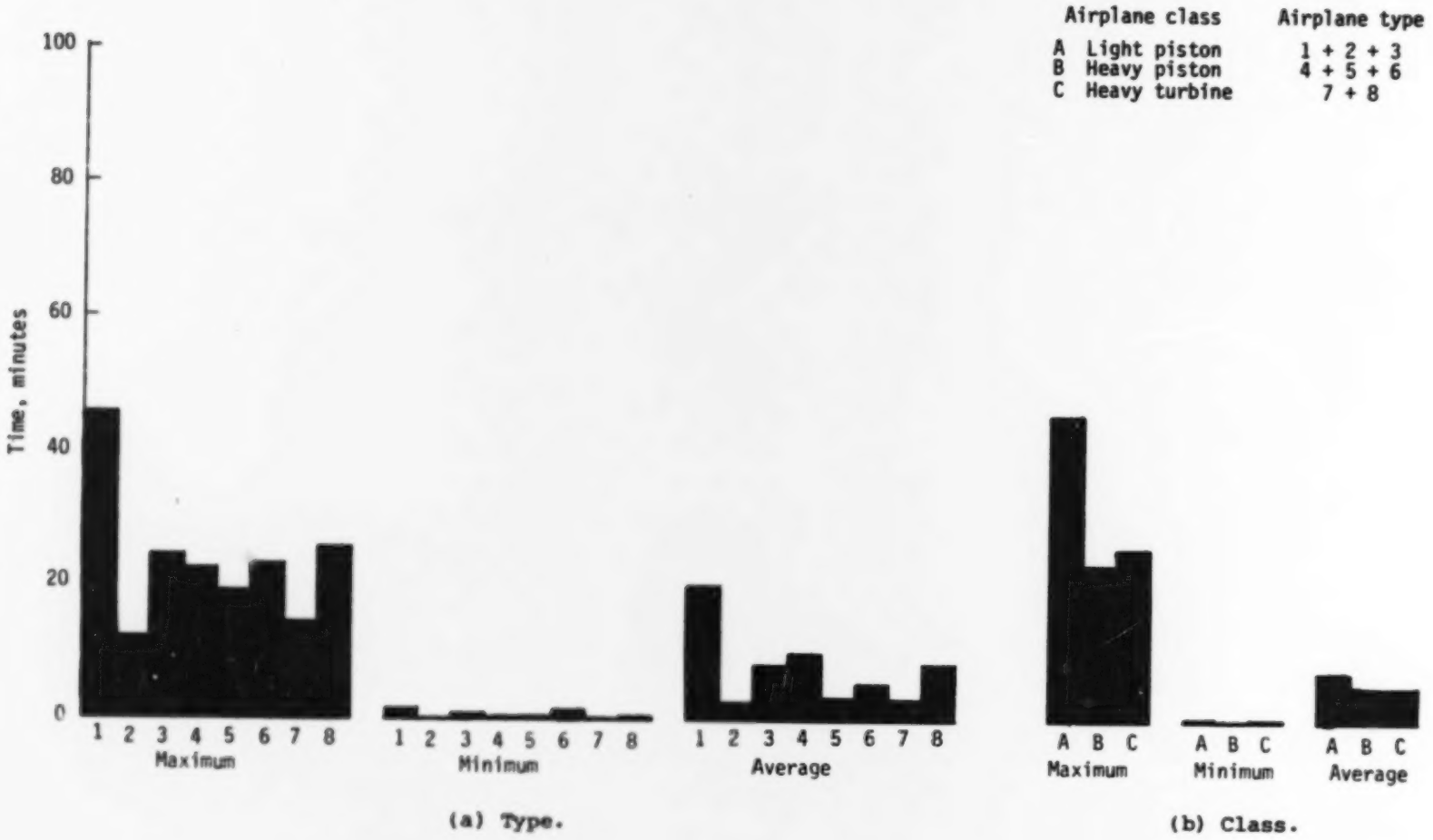

Figure 6.- Turning time for different airplane types and classes.

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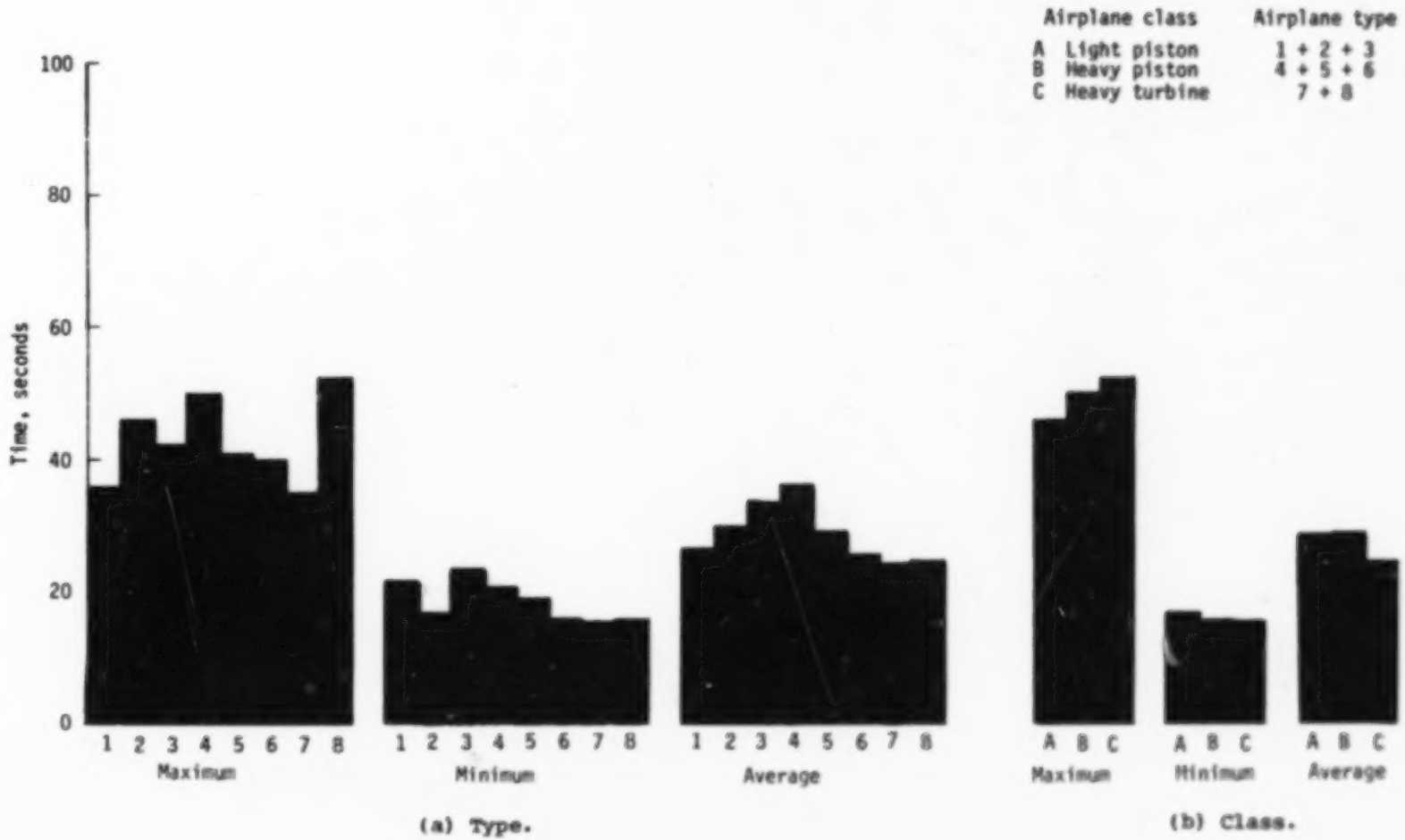

Figure 7.- Time per turn for different airplane types and classes. Maximum and minimum values are based on averages per flight.

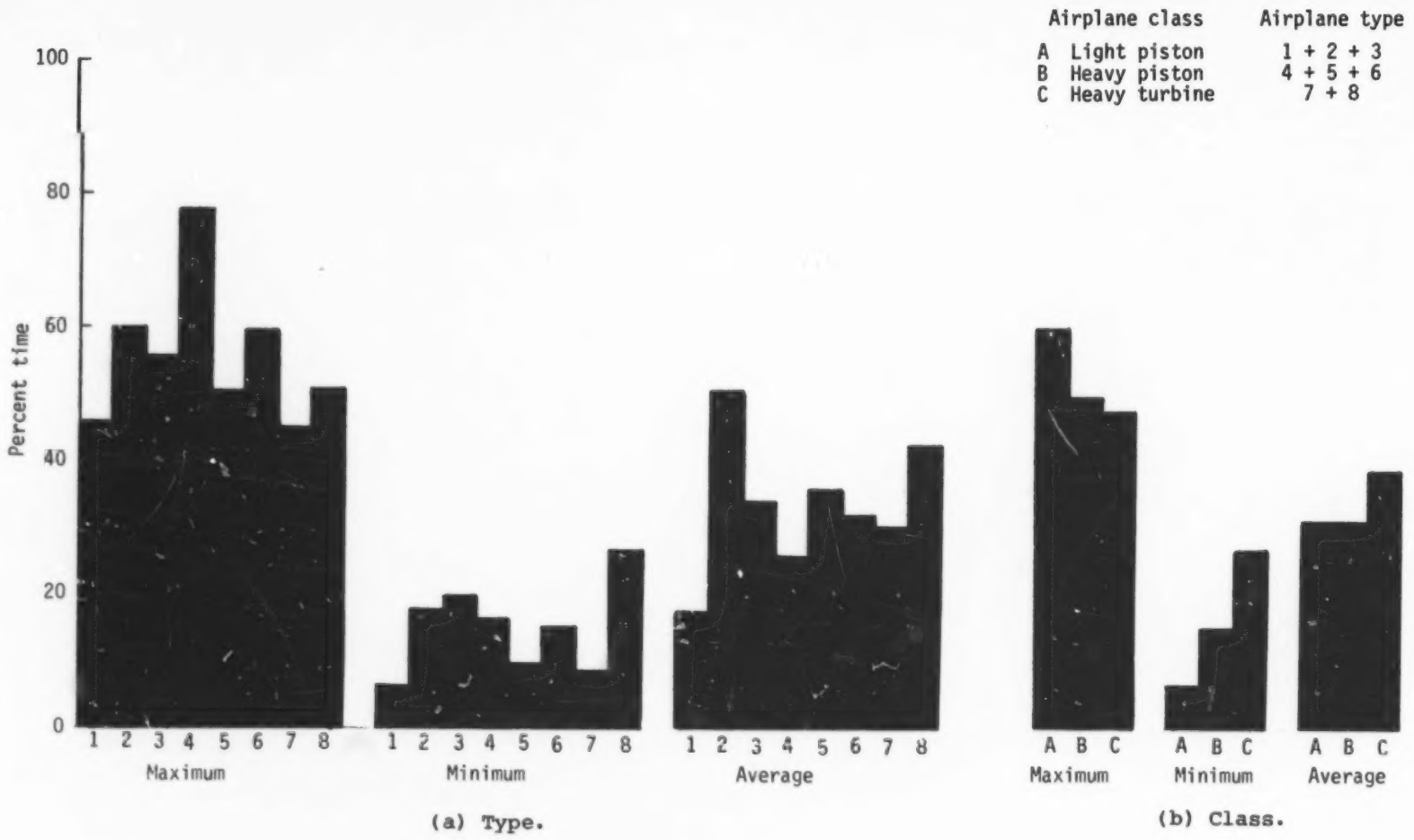

Figure 8. Percent of flight time used for ferrying for different airplane types and classes.

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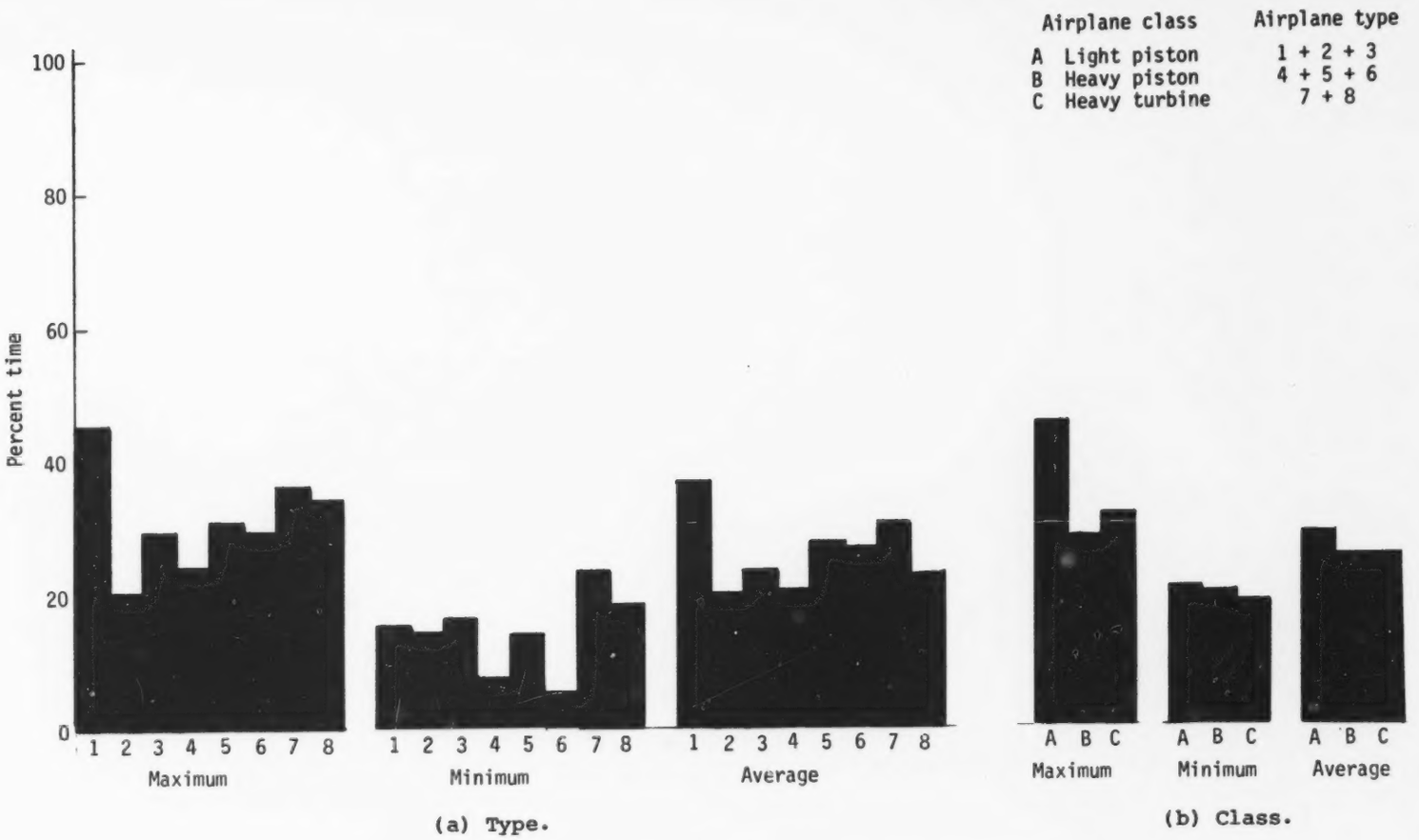
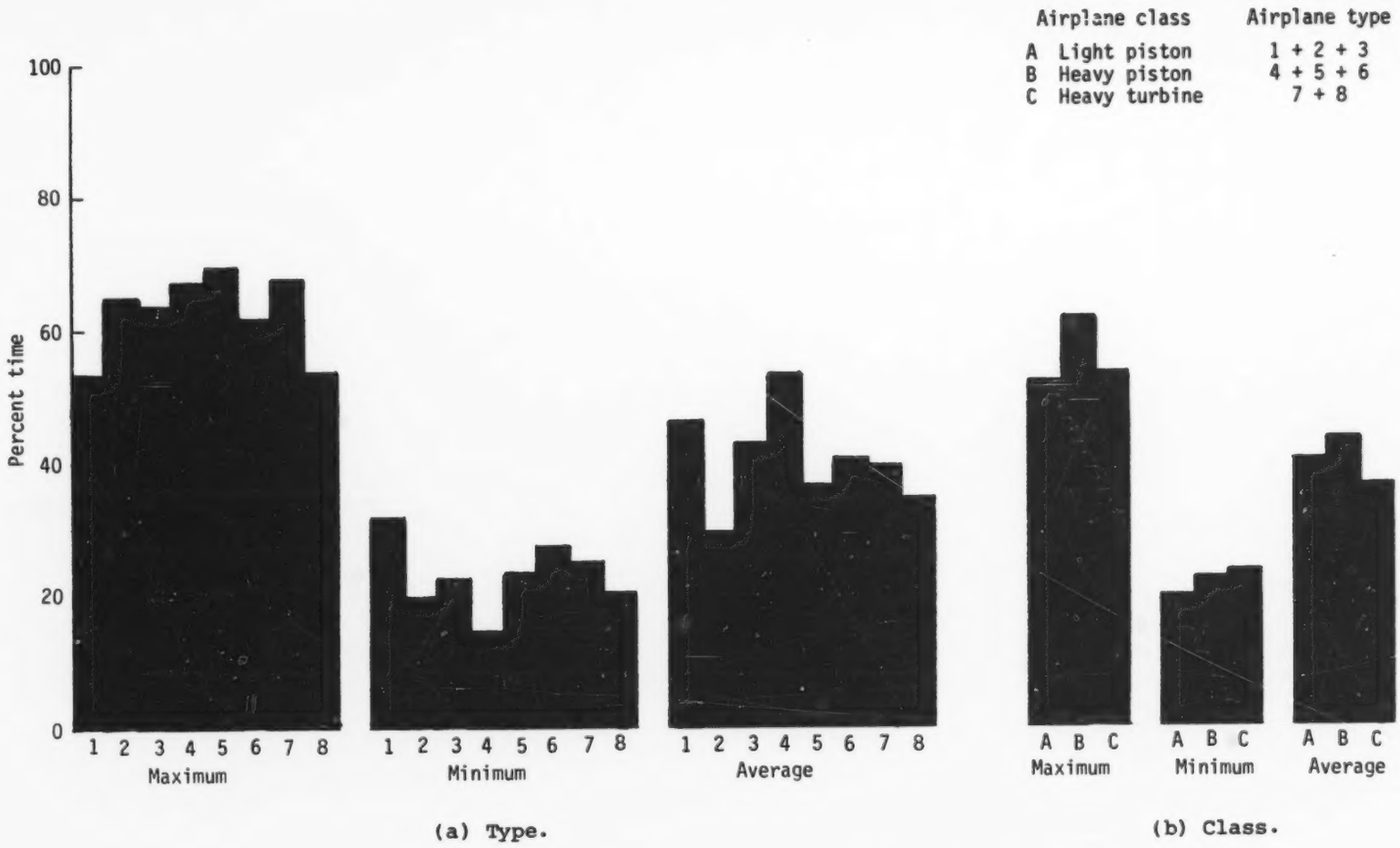


Figure 9.- Percent of flight time for spreading for different airplane types and classes.



(a) Type.

(b) Class.

Figure 10.- Percent of flight time for turning for different airplane types and classes.

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15. Supplementary Notes

16. Abstract

A study of the time structure characteristics of agricultural airplane missions has been made by using records from NASA VGH flight recorders. Results from the study indicate flight times varied from less than 3 minutes to more than 103 minutes. There was a significant reduction in turning time between spreading runs as pilot experience in the airplane type increased. Spreading runs accounted for only 25 to 29 percent of the flight time of an agricultural airplane. Lowering the longitudinal stick force appeared to reduce both the turning time between spreading runs and pilot fatigue at the end of a working day.

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